DATA ENVELOPMENT ANALYSIS TO ASSESS PRODUCTIVITY IN THE UNITED STATES AIR FORCE MEDICAL SUPPLY CHAIN

GRADUATE RESEARCH PAPER

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Abstract

The current United States Air Force Medical Supply Chain supports healthcare operations based largely on the network configuration of its contracted Third Party Logistics providers. Six years from conception to initial award in 1992, Defense Logistics Agency's triumph with the Medical Prime Vendor contract marked fulfillment of significant and longstanding gaps in cost, quality, and timeliness for all three services. This study seeks further gains, specifically, system-wide efficiency and effectiveness optimality from alternative network reconfiguration.

Utilizing a Data Envelopment Analysis model created by Dr. Paul Jensen, formerly of the University of Texas, each of 73 Air Force Medical Treatment Facilities was assigned a baseline efficiency rating in the current structure. Efficiency was calculated based on the facility's capability to process input(s) to output(s). Effectiveness, operationalized as application of the appropriate strategy "to get the job done," was assessed as a function of lead time using average delivery days. Capacity utilization was also considered. Contract specifications and manpower authorizations for FY 2011 in addition to sales, receipts, order lines, and lead times for the previous two years were inputs and analyzed. Through a combination of contract and user-defined constraints, the model indicated several optimal locations for aggregate ordering centers by region, ultimately suggesting multiple virtual hub-and-spoke networks. Though not the focal point, the manpower and asset implications naturally became of significant consequence when considering the potential for a restructuring of this magnitude.

DEDICATION

I thank Christ for His example and pray that I might follow in His steps…
For this I was called…

1 Peter 2:21

Acknowledgments

First, I would like to thank God that He grants us new mercies daily.

I am very grateful for my son, Jacob. I know these past 12 months have not been easy on him, but he has remained faithful. I love you, son.

I would also like to thank Col. Don Faust and Lt. Col. Chris Canales, both for being instrumental in my career as well as sponsoring my AFIT degree and research. Six years ago, Col. Faust selected me for the medical logistics internship as a direct commission from the Army enlisted ranks and (then) Maj. Canales was assigned my preceptor, largely responsible for my devotion to this field.

I am especially grateful to Dr. Martha Cooper of The Ohio State University and adjunct at AFIT. She was one of one that could keep up with my stream of consciousness ramblings as I struggled through my research problem. Her eloquence of style and professionalism never ceased to amaze me. You are a class act and I already miss you.

I would be remiss if I did not express my sincere appreciation to my advisor, Lt. Col Skipper, for his guidance. He never pulled any punches about what I needed to do and when time got short, he unleashed the KITA I needed to get it together. Thanks, sir.

Last but "most assuredly" not least, a heartfelt muchas gracias to all of 11J who sounded more like a comic book line-up than IDE class: Finance and CE Guys, Maintenance vs. LROs, the Pilot and the Nav, two Todds & a Ted, Sweater Dude, Dr. Doctor, National Guard Medic, Translator…and in particular, Lt.Col. (Sel) Yira Muse and her 472 Americanos. I wish each of you the best in your future endeavors.

Tereca V. Benton

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DATA ENVELOPMENT ANALYSIS TO ASSESS PRODUCTIVITY IN THE UNITED STATES AIR FORCE MEDICAL SUPPLY CHAIN

I. Introduction

Background

Since 1992 Department of Defense (DoD) has partnered with commercial Third Party Logistics providers (3PLs) as part of Defense Logistics Agency's (DLA) Medical Prime Vendor Program (PV) for class VIII medical supply support at its healthcare facilities all over the United States, Europe and the Pacific (Figure 1). Historically, the Army, Navy and Air Force purchased their medical supplies separately, from a multitude of sources easily waiting 30-60 days for final delivery and at a significant mark-up (Cardella, 1999).

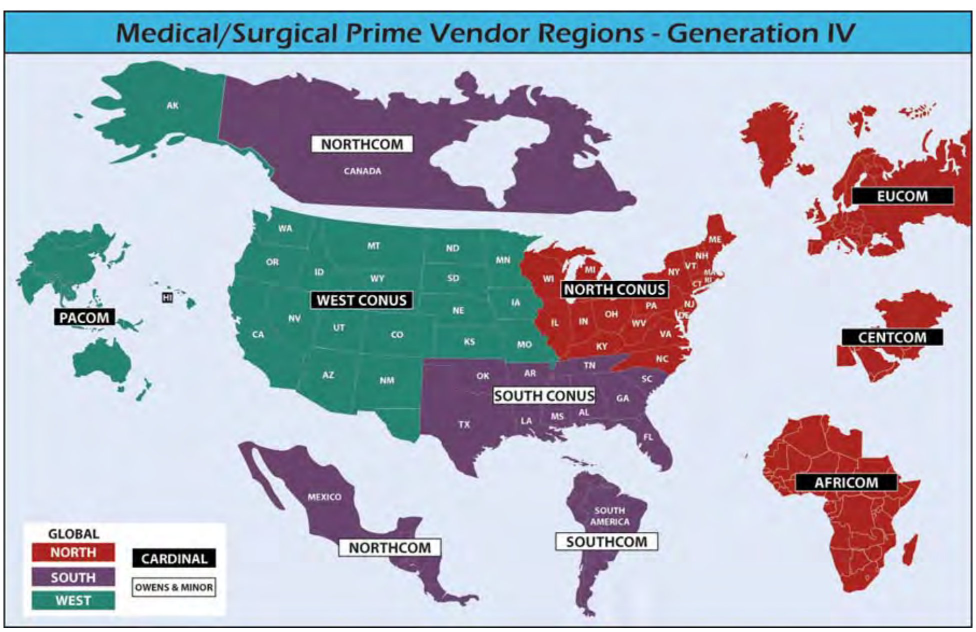

Figure 1. Prime Vendor Regional Map

The advent of the program could not have been better timed; recollections of stockpiles and the transport of expired supplies, lack of accountability resulting in double-orders, and the stove-pipe bureaucracy are well documented in media accounts and military chronology of lessons learned from the war in the Persian Gulf War (O'Leary, 2003). Recently awarded to two industry leaders, the fourth generation of the contract (Gen IV) of PV shares the responsibility for all of DoD medical/surgical supply business between Cardinal Health and Owens and Minor. Though revising the statement of work in successive generations, many services remain consistent ultimately enhancing government garrison and wartime capabilities (Figure 2).

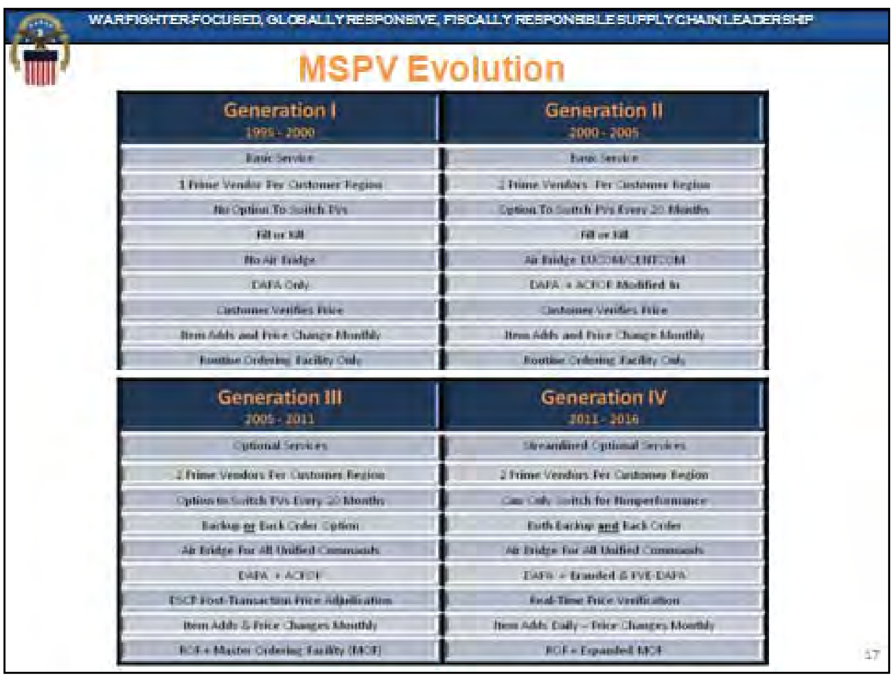

Figure 2. 27 Apr 2011, DLA Summit Brief (Slide 17)

Following are included products offering the greatest benefit to medical logistics staff and/or directly impacting the military mission: War Readiness Materiel support,

automated payments, reduced inventory requirements, guaranteed fill-rates, and elective service levels. Perhaps more relevant to end-users, PV program offers: total delivered price, next day delivery for usage items, emergency delivery, back-up and back-order option, and electronic ordering (dmmonline, 2011).

Purpose

The request for this Graduate Research Paper originated from the Chief of the Medical Logistics Division, Colonel Don Faust at the Air Force Medical Operations Agency (AFMOA) located at Fort Detrick, Maryland acting on behalf of the Office of the Air Force Surgeon General. The Medical Logistics Division houses the Air Force Medical Prime Vendor Management Office which, along with program oversight acts as the interface between AFMS customers and DLA. The sponsor requested a review of the current AFMS supply chain network structure as it specifically relates to Medical PV support and future savings potential via virtual order aggregation centers or “parent-child relations” similar to hub-and-spoke networks and according to the fee schedule published in Gen IV contracts awarded on 4 April 2011. The terms aggregate ordering center, parent, or hub are used interchangeably to identify facilities operating in a supporter role in relation to one or more spoke, node, or delivery site(s). AFMOA requested a means to assist with the identification of potential for system-wide benefits as well as suggest optimal locations for aggregate ordering centers given multiple constraints, both user and contract-defined. This model will also support manpower and asset planning for both garrison and contingency operations at strategic and lower levels.

Problem Statement

It is outside the authority of the government to direct the contractor's use of distribution centers (DCs), sources of supply, or similar. PV providers autonomously elect whatever suitable supply chain network design to support USAF MTFs IAW contract terms, e.g. "Owens & Minor's Distribution Centers shall be prepared to service the ROFs listed in the attachments." Currently the AFMS continues to reserve the exercise of numerous Service Level Elective Facility (SLEF) options at the local level (Figure 3).

Figure 3. 27 Apr 2011, DLA Summit Brief (Slide 15)

Consequently, leadership is interested in whether or not a more efficient and effective supply chain network is achievable across the USAF healthcare system. Discussion herein of alternate configuration(s) for consideration by AFMOA, e.g. hub-and-spoke,

implies “virtual” relationships only and would consist of aggregation of administration tasks up to contract maximums where applicable. Efficiency and effectiveness operational definitions and productivity measurements are given. This research provides AFMOA with an analysis of the current structure as a function of efficiency where sales, receipts and individual line items represent outputs.

Primary Research Question

As a federal agency with the dual mission of providing non-profit healthcare delivery in garrison while conserving the fighting the strength in theater, efficient and effective operations are central to the AFMS’ mission. Without authority to impact the medical logistics supply chain network outside organic military assets post-contract award, AFMOA is vested in optimizing SLEF options at each of its accounts. Now in its fourth generation, PV has provided services to each of the 73 MTFs as stand-alone customers, assessing fees separately and based on the individual needs of each account. Varying levels of service are available at the standard rate, result in either an increase or discount based on options, and currently exercised at the local level. Snapshot glance of raw data suggests the current structure is possibly not optimal. AFMOA is interested in enterprise-wide benefits, primarily dollars and then manpower, promoting more flexible, agile, and reliable response capabilities in the long run. This research sought to answer the following question:

How efficient and effective are MTFs operating in the current medical supply chain network structure as part of the Medical PV program contract?

Investigative Questions

The research utilizes a model that provides an efficiency measure for each organization by comparing all others to the "one best" in the system it selected. Towards identification of an appropriate model as well as throughout various stages of the research process, several investigative questions had to be answered:

1. How are efficiency and effectiveness, i.e. productivity defined?
2. Is there a capacity utilization issue that needs to be addressed (with respect to exercise of SLEF options)?
3. How will these measures be quantified in a military context? Do measures exist that apply to the AFMS?
4. Selection/validation of model (DEA vs. traditional methods)
5. What makes a good hub? What, if anything, would disqualify a site for consideration?

Methodology

This study incorporates both qualitative and quantitative methods during phases of investigation and analysis. Based on AFMS reliance on 3PLs through the PV, the researcher determines whether AF healthcare facilities are operating efficiently and effectively in the current medical supply chain network configuration. Productivity assessments use a Data Envelope Analysis model (DEA) created by Dr. Paul A. Jensen of the Operations Research Group at the University of Texas.

The study examines the likelihood that conventional measures will be found unsuitable for the AFMS construct as well as the plausibility that a combination of inputs will have varying degrees of impact on measured outcomes. Consequently, the model is run using singular and multiple inputs with varied groupings for comparison. AFMOA provided historical data spanning from 2004 through 2011. Different approaches to distribution problems as well as multiple measures for productivity were reviewed before selecting DEA as most appropriate given its applicability to public sector, not-for-profit and governmental agencies (Ray & Chen, 2009).

Data

Multiple sources contributed to the data pool for this research effort. Lieutenant Colonel Christopher Canales, Deputy Chief of Logistics Division, AFMOA provided manpower authorizations listing (Appendix C) and offered a strategic perspective regarding the potential for future AFMS capabilities in support of the larger mission of the Air Force. Mr. Kilby Gray and TSgt Eugene Parrotta, both of Logistics System Support Branch, AFMOA provided receipts and pipeline data from the supply ordering system, i.e. Defense Medical Logistics System Support (DMLSS). Mr. Howard Dildy, Systems Analyst at AFMOA, provided monthly sales data from the Joint Medical Asset Repository. The web portal managed by DLA includes a wealth of information; Medical/Surgical PV program being one of many at the DOD-level (www.dmmonline.gov). The crux of the study relied on information and data provided individually and cooperatively by Mr. Joseph Meyer, Program Manager for Air Force

PV at AFMOA. Mr. Meyer supplied both PV contracts in entirety, the DLA Summit PV Gen IV “Awards & Features” presentation, and the exercised SLEF options for each of the facilities including actual rates paid in FY10.

Absent actual sales data in accordance with terms of the newly awarded Gen IV contract, planned to “go live” beginning in December 2011, the model synthesized optimality using sales figures as current as the last full month before the paper was submitted, i.e. April 2011(Figure 4). Raeshon Sykes, Global North regional Contracting

Figure 4. 27 Apr 2011, DLA Summit Brief (Slide 18)

Officer, explained that while awarded in 20-month intervals, PV modifications consider the previous 12-rolling months of sales when calculating annual purchase commitments. This feature provided justification for using annual sales and receipts data vice the monthly amounts given as well as offered flexibility not previously considered. Total

sales, lines items processed/received, manpower authorizations, days of service delivery (delivery frequency), average lead time, and basic service distribution fee were all variables considered for analysis.

Scope

The request for potential enterprise-wide benefit coupled with stated willingness for partial and/or incremental implementation of aggregate ordering centers drove the inclusion of all facilities vice a sampling for baseline measure. In totality, the study encompassed 73 AF Routine Order Facilities (ROFs) from 2010 remaining eligible and participating in 2011 in accordance with the most recent listings. Because manpower was a consideration, only those MTFs with active duty authorizations were included (Table 1). Facilities were then rated within their respective regions, consistent with Tricare Regional Business Offices (TRBOs) based on AFMOA's advisement that localized implementation of aggregate ordering centers via virtual hub-and-spoke systems was a possibility should the findings indicate such actions. For ease of program management however, the clear preference was consistency across the AFMS system.

The request for system-wide analysis of the current system and a user-friendly instrument elicited a model capable of importing data from commercial-of-the-shelf (COTS) systems for maximum utility. The study employed an "Add-in" application to Excel, created by Dr. Paul Jensen. Both DMLSS and JMAR export data in Excel currently. Airmen in a theater environment, limited in technology and equipment would likely have access to this COTS software by Microsoft™.

Table 1. Medical Planning and Programming Tool

SRAN	O/C	MAJCOM	MTF	MTF Authorization	MPPT Report FY12	New PLD	
	CONUS	AMC	McChord	64	1	1	
2835	CONUS	AFMC	Hanscom	128	8	8	0
3029	CONUS	AETC	Vance	131	5	8	3
3099	CONUS	AETC	Laughlin	137	7	8	1
2816	CONUS	AFSPC	L.A.	141	6	8	2
4419	CONUS	AETC	Altus	152	9	8	-1
2504	CONUS	AFSPC	Buckley	153	8	8	0
4659	CONUS	AMC	Grand Forks	153	10	8	-2
3022	CONUS	AETC	Columbus	155	10	8	-2
3030	CONUS	AETC	Goodfellow	158	4	8	4
4626	CONUS	GSC	Malmstrom	191	9	9	0
4613	CONUS	GSC	F.E. Warren	192	10	9	-1
4610	CONUS	AFSPC	Vandenberg	194	11	9	-2
4690	CONUS	ACC	Ellsworth	207	10	10	0
7054	CONUS	AFDW	Bolling	218	8	10	2
4621	CONUS	AMC	McConnell	224	11	11	0
4418	CONUS	AMC	Charleston	231	12	12	0
4855	CONUS	AFSOC	Cannon	232	12	12	0
4625	CONUS	GSC	Whiteman	238	11	12	1
4830	CONUS	ACC	Moody	239	14	12	-2
2805	CONUS	AFMC	Edwards	241	10	12	2
4801	CONUS	ACC	Holloman	250	13	13	0
4528	CONUS	GSC	Minot	260	10	13	3
4661	CONUS	ACC	Dyess	268	11	13	2
4620	CONUS	AMC	Fairchild	269	15	13	-2
4809	CONUS	ACC	Seymour Johnson	270	15	13	-2
4819	CONUS	AETC	Tyndall	280	11	14	3
4460	CONUS	AMC	Little Rock	281	13	14	1
4497	CONUS	AMC	Dover	285	15	14	-1
2520	CONUS	AFSPC	Patrick	286	16	14	-2
3300	CONUS	AETC	Maxwell	287	17	14	-3
3089	CONUS	AETC	Randolph	292	11	14	3
4417	CONUS	AFSOC	Hurlburt	317	15	14	-1
4803	CONUS	ACC	Shaw	325	17	15	-2
4686	CONUS	ACC	Beale	330	11	15	4
4469	CONUS	AFMC	Kirtland	334	17	15	-2
4608	CONUS	GSC	Barksdale	341	13	16	3
4897	CONUS	ACC	Mountain Home	346	18	18	0
4484	CONUS	AMC	McGuire	353	25	16	-9
2020	CONUS	AFMC	Hill	359	15	17	2
2060	CONUS	AFMC	Robins	391	15	18	3
4877	CONUS	ACC	Davis-Monthan	400	17	18	1
2500	CONUS	AFSPC	Peterson	429	15	19	4
3020	CONUS	AETC	Sheppard	463	27	24	-3
2030	CONUS	AFMC	Tinker	464	19	20	1
4887	CONUS	AETC	Luke	498	21	22	1
4814	CONUS	AMC	MacDill	577	30	26	-4
4600	CONUS	ACC	Offutt	641	33	29	-4
4407	CONUS	AMC	Scott	649	43	35	-8
7000	CONUS	USAFA	USAFA	710	30	39	9
4800	CONUS	ACC	Langley	1021	41	50	9
4425	CONUS	AFDW	Andrews	1108	77	57	-20
4852	CONUS	ACC	Nellis	1264	43	60	17
2823	CONUS	AFMC	Eglin	1446	61	70	9
3010	CONUS	AETC	Keesler	1599	99	80	-19
2300	CONUS	AFMC	WP	1818	86	88	2
4427	CONUS	AMC	Travis	2041	100	100	0
3047	CONUS	AETC	Lackland	2265	188	188	0
5284	OCONUS	PACAF	Kunsan	153	26		
5004	OCONUS	PACAF	Eielson	161	10		
5240	OCONUS	PACAF	Andersen	199	11		
5260	OCONUS	PACAF	Hickam	239	13		
5294	OCONUS	PACAF	Osan	339	37		
5205	OCONUS	PACAF	Misawa	363	25		
5202	OCONUS	PACAF	Yokota	433	69		
5270	OCONUS	PACAF	Kadena	498	36		
5000	OCONUS	PACAF	Elmendorf	1138	68		
4486	OCONUS	USAFE	Lajes	127	8		
5655	OCONUS	USAFE	Incirlik	236	47		
5606	OCONUS	USAFE	Spangdahlem	325	25		
5682	OCONUS	USAFE	Aviano	347	24		
5612	OCONUS	USAFE	Ramstein	544	62		
5587	OCONUS	USAFE	Lakenheath	788	58		

Assumptions/Limitations

The following assumptions and limitations were identified. The use of future fee schedules to assess organizational efficiency, productivity, effectiveness, i.e. optimality metrics to the extent decision makers expect to make real-world decisions based upon model outcomes assumes some stability in the system, e.g. deterministic demand. Supply data is retrievable nearly as far back as the DMLSS system coming online at MTFs, version 1.0 deployed in 1997 to 68 sites (Clarke, 1997). Though trending analysis of garrison activities suggests the practice as sufficient, military operations tempo can become quite stochastic.

Although the sponsor requested system-wide analysis, as indicated in Figure 3 the addition of delivery sites is only an option for those CONUS ROFs. Additionally, the intent to assess “effectiveness” as a measure of timeliness through utilization of average lead times is limited in OCONUS. Per Mr. Meyer, EUCOM ROFs are serviced via USAMMC’s “Medical Air Bridge” (Figure 5). Moreover, delivery frequency data was not provided on the OCONUS facilities for input to the model, thus no comparison was possible. Although efficiency ratings were calculated, this variable was not considered in the break-outs by region, i.e. it was not modeled for OCONUS.

Addressing efficiency and effectiveness from a cost perspective without regard for the “soft” customer service aspects has implications for implementation not addressed in this study. The manner that something is provided as well as the quality of products offered matter to the end-user. Brand new Airmen and those new to the supply custodian role will likely have the easiest time adjusting without previous experiences

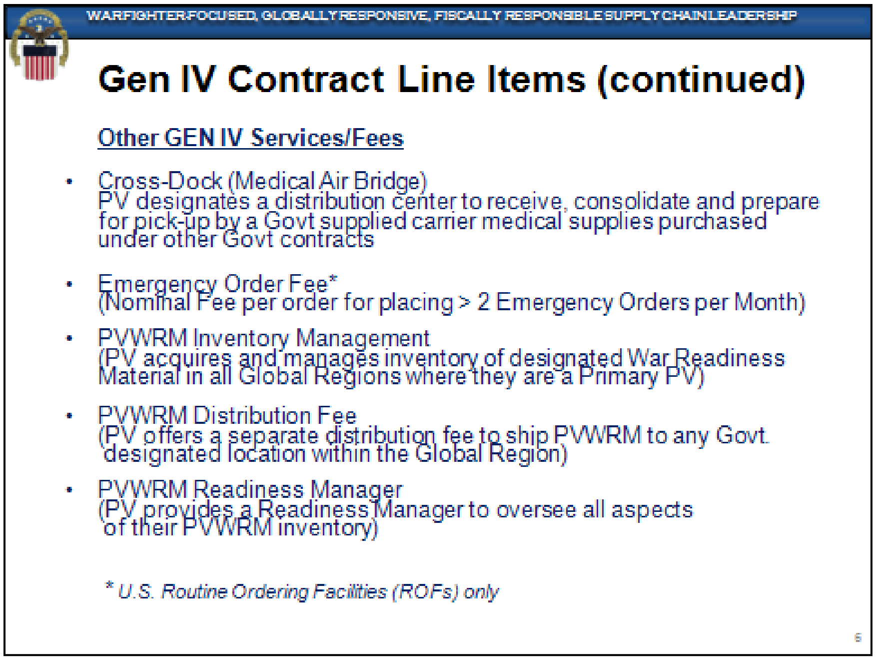

Figure 5. 27 Apr 2011, DLA Summit Brief

with which to form expectations (Meyer & Schwager, 2007). Should plans for implementation be initiated either as a pilot program, in a region or service-wide, the impact on customer service might be a good area to begin. Specifically, that insertion of a "middle-man" or transition to virtual service centers causing perceived loss of service is not inevitable (Suchan, 2001).

A final researcher assumption involved hub selection and disqualification. Prior to reviewing any data, it was determined only facilities with inpatient services and categorized as traditionally medium or larger would be considered for aggregate ordering designation. This decision was based on several different factors. First, these facilities with surgical capabilities would have larger "Master Catalogs" from which to place their orders offering better selections to their customers, thereby increasing

service levels simply by association. Second, these facilities are more likely to have Emergency Rooms and/or Urgent Care services with later customer service hours in medical logistics offering potential for better support than many of the smaller bases currently receive as well. Third, the premise of this study was largely based on the fact that these larger facilities are taking advantage of volume discounts not otherwise available to smaller clinics and, as stated previously, detriment of service was not an option. The supported facilities are added to the contract of the ROF, subject to its contract terms and options. Having a small facility serve as a hub with larger facilities as its nodes would drive an increase in the smaller facilities service levels, possibly unnecessarily, counter to the efficiency the study is looking for in the first place. While none of the literature reviewed provided scientific evidence to support small facilities as a poor choice, this research did not consider the option.

Moreover, the researcher did not consult manpower data regarding minimum requirements and specific tasks related to supply procurement. The assumption being whatever administrative burden associated with the increased workload of supporting multiple additional facilities, it would more readily be absorbed by the larger MTFs due to their greater manpower authorizations (Table 1). The researcher does recognize while greatly outnumbering in “Airmen authorized,” these numbers indicate absolutely nothing about the quality of support provided in comparison. Therefore, while smaller MTFs were excluded from hub consideration based on manpower and other factor, no evidence was provided in the literature that supported bigger would necessarily be better from a quality perspective.

II. Literature Review

AFMS Construct

The current network comprised of stand-alone Routine Ordering Facilities (ROFs) may not be the most efficient and effective way to conduct medical logistics operations with the benefit of a 3PL Prime Vendor. Serving as the basis for this study, it was critical to operationalize these performance measures as they apply in an AFMS supply chain context with the goal of assigning meaningful and quantifiable measures for analysis. The inputs of the AFMS supply chain network being quite similar to industry firms lack a good argument for unique measures of performance. The nature of the outputs and unavailability of “market prices” with which to evaluate production in the public and government sector creates the dilemma (Ray & Chen, 2009).

Supply Chain Distribution Problem-Fixed Charge

Industry estimates begin at 30% regarding distribution costs, citing its vitality in product pricing determination (Jawahar & Balaji, 2007). Traditional approaches to transportation problems assume this cost and the quantity of transported units are directly proportionate (Diaby, 1991). This method proves inadequate in “real world” applications. The literature contained dozens of fixed charged transportation problems for practical use. The costs considered in this kind of problem were either: a. fixed charge-assessed anytime a “nonzero quantity is transported,” b. continuous cost-increases in a linear fashion, dependent on the quantity transported (Jawahar & Balaji, 2007).

The option for additional delivery sites as it pertains to PV support seemed a possible candidate for fixed charge modeling. The paper by Jawahar and Balaji discussed a shortfall in previous work, extensively addressing single-stage and multi-stage problems but nothing in between. Their research addressed the two-stage distribution problem modeling both types of costs. Relevant to the AFMS construct, the aggregate ordering center hub-to-spoke relationship, albeit virtual, represents a two-level hierarchical relationship. Though the cost associated with additional sites is "fixed," it does not fit the definition above. The additional delivery site fee would be calculated along with the basic service level and any other SLEF options as part of the "total supply price." The "unit cost of distribution" variable would not appropriately measure the cost "from distribution center *i* to customer *j*" (Jawahar & Balaji, 2007).

Supplies are delivered via PV designated DCs and, as previously mentioned, the government does not interfere with how the contractor opts to carry out this function. The principle that DCs would continue support to facilities IAW Attachment IIA of each contract presumably best suited to their supply chain network needs was treated as exogenous and not modeled. Therefore, the fee assessed to the aggregate ordering hub, while most assuredly covering distribution costs would not serve the purpose desired.

Capacity Utilization

Ultimately impacting supply pricing at each of the MTFs, a few of the SLEF options appearing to have close ties to the output measures were examined. Commonly presented in the literature was the view that capacity output and utilization tended to be

“inherently short-run notions,” reliant on semi-fixed inputs of the organization (Berndt & Morrison, 1981). Of particular interest relative to lead times was the delivery frequency option and possible implications for capacity utilization. Borrowing from the widely accepted manufacturing model that contrasts what a system was designed to do at its maximum and what it actually does encouraged further review of this SLEF (Heizer & Bender, 2008). The difference between this notion of more capital utilization and Wharton’s index for capacity utilization is that the potential compared to actual is taken from “previous peak values of the output-capital ratio” rather than what an engineer intended the process to do (Berndt & Morrison, 1981). For example, five days delivery frequency is built-in to the basic service distribution fee. Considering either or both of these generally accepted measures for utilization would return misleading results.

Delivery support provided daily at no additional cost indicates the contractors’ ability to produce the service. This meets both the intent for “design capacity” as well as “potential output” where DCs are providing that service to other MTFs. Continuing this line of logic, any “actual” service-level less than what the contract offers, i.e. the system was designed to do, or potential amount would be represented as the numerator in the following formula, rendering a “utilization” percentage (Heizer & Render, 2008):

$$\text{Utilization} = \frac{\text{Actual Output}}{\text{Design Capacity (Potential or Maximum Possible)}}$$

Adopted from Wharton Measure and Murray Foss (Berndt & Morrison , 1981)

Bernt and Morrison explained that while the optimization challenge facing most firms is typically geared towards maximizing profits from various sources, they present

an alternative problem. Theirs considers “minimizing variable costs” as a function of output flows, the price of variable inputs, and various service flows. This dual variable cost function is represented by:

$$Cv = g\ (Y, P_v, x)$$

It relates to capacity because average total cost includes both variable and average fixed costs. Capacity output (Y*) as defined by Bernt & Morrison (1981) is that output level where average total cost is minimized, represented by the function:

$$Y^* = h\ (P_v, x, P_x)$$

The concept of capacity output as represented by the low point on the short-run average total cost curve is not theirs, nor is it new. Furthermore, this cost function for Y* does not apply in a competitive firm situation where the output level is geared towards maximizing variable profits. While the businesses the government does business with are most assuredly in business to be in business, the AFMS has an entirely different mission. A discussion of efficiency and effectiveness follows. A much more appropriate definition for capacity utilization in the AFMS construct is expressed as:

$$u = \frac{Y}{Y^*}$$

For purposes of this research, data regarding flow of output is available in the form of average pipeline times as well as order lines. Actual pipeline times could be compared to capacity by contact terms that guarantee a certain percentage fill-rate, but this becomes complicated by facility exercise of SLEF impacting delivery frequencies. Order lines are a common output measure reviewed by leadership at AFMOA, however

actual has no real capacity comparison in this regard. The same would be true for sales and receipts. A price could be associated with variable inputs, e.g. basic distribution fees can be calculated from sales, cost of manpower can be assessed, etc. Absent critical elements of the cost function, although undoubtedly providing a more accurate accounting, due to the nature and scope of the study, it was abandoned.

Application of the former model(s) to SLEF delivery frequency for its simpler input variables would not only indicate poor production output on the part of the contractor, quite possibly erroneously as a result of local decision to exercise decreased service, but would further fail as any meaningful measure of how the AFMS is operating under the current system. These models, in and of their selves, lack in accounting for the positive outcomes derived from not “maxing out” the machine, discussed briefly by Berndt and Morrison. Opting for a lesser frequency, possibly reduced to once per week, discounts the basic distribution fee up to .25%, reduced from Gen III at .60% and possibly related to its justification for its selection previously (Appendix B, Slide 7).

Central to capacity planning are figuring out how much and when “it” is needed. (Heizer & Render, 2008). While operating costs are certainly a deciding factor, the overarching importance of these decisions should not be reduced to whether or not a discount can be applied. Ordinarily exercised at 20-month intervals, as in previous generations, PV could be considered a long-term commitment. It is not uncommon for decision makers to have long since moved by the time their choices are enacted. Additionally, these decisions affect the competitive nature of PV as a source of supply and can greatly ease the management of procurement activities and warehouse operations

Stevenson, 2007). Though mandated as the primary source for Class VIII supplies at participating ROFs (dmmonline.org), reportedly less than half of the MTFs are compliant (DMLSS SOS report, 2011). Whether or not this and other options provided the appropriate level of service was beyond the scope of this study and not modeled directly, though delivery frequency certainly had an impact on pipeline time as will come to light in Chapter 5. When modeling potential parent-to-child relationships, only equal or greater levels of service were considered due to the presumption that SLEFs were selected based on the "effective capacity" at the MTFs, where employee skills were also considered. In this case, effective capacity is said to be design capacity of the organization minus certain allowances, such as "personal time, maintenance, and scrap" represented by the formula (Stevenson, 2008):

$$\text{Efficiency} = \frac{\text{Actual Output}}{\text{Effective Capacity}}$$

Quantifying Productivity

"Efficiency" is said to mean getting the job done well while minimizing resources and waste. Similarly, "effectiveness" is related to, "doing the right thing" and "using the correct strategy" (Heizer & Bender, 2008). In an operational management environment, the more efficiently resources are transformed to goods and services, the greater value has been added and the more productive the plant is. Though business practices might be different, this principal is fundamental.

Presenting a challenge is the direct application of traditional productivity computations in the AFMS construct. The issue arises partially from the fact that

productivity measurements require "specific inputs and outputs" such as labor hours or units produced (Heizer & Bender, 2008). Therefore, although the cornerstone of labor productivity measures, the AFMS logistics mission tends not to readily translate into the formula represented by:

$$\text{Labor Productivity} = \frac{\text{Units produced}}{\text{Labor-hours used}}$$

More seriously considered but also abandoned was the Multi-Factor Productivity formula represented by:

$$\text{Productivity} = \frac{\text{Output (units)}}{\text{Labor + Materiel + Energy + Capital + Misc}}$$

It typically includes capital, materials, energy and other factors along with labor as possible inputs. Relative to its more comprehensive accounting, it is sometimes referred to as Total Factor Productivity and believed to account for "all" inputs. Due to the changing nature related to the production of goods and services from resource inputs to outputs, this ratio is considered directly proportionate to efficiency. That is, the better able inputs combine to create goods and services, while minimizing waste, the more efficient those resources were utilized. Its inapplicability to the AFMS supply chain is shared with much of the service sector who may find it difficult to define their end product (Heizer & Bender, 2008). Additionally, although military medical logisticians provide a critical support function to healthcare professionals and ultimately patients similar to their civilian counterparts, these military men and women are Soldiers, Sailors, Marines, and Airmen first. Similarly, with respect to provision of no and low-cost public

services, even when co-pays are assessed for materiel, they fail to “reflect either the marginal benefit to the consumer or the marginal cost to the producer” (Ray & Chen, 2009). This dynamic counters the widely accepted productivity ratio, thereby discounting its value for assessing AFMS’ supply chain network structure.

While researching economic and engineering approaches to productivity, the principle of “decision making efficiency” and its applications in Data Envelopment Analysis (DEA) emerged from the literature, particularly appropriate for its, “special reference to possible use in evaluating public programs,” with roots in DoD (Charnes, Cooper, and Rhodes, 1978). The authors comment on other efficiency measures in economics and engineering, relating their own ideas to those fields for “greater unity.” The gentlemen distinguish their model for its roots in managerial decision making, significant to this study for its connection to the definition of “effectiveness” already presented. Likewise, proceeding as though local SLEF decisions are made with the best of interests, their approach to efficiency is directly associated with effectiveness.

Programs, firms, organizations and the like are called “decision making units” (DMUs) and when discussed collectively, are assumed to have shared characteristics, likening their multiple inputs and outputs which are stated to take variable forms as long as they can be presented in ordinal measurements. The pioneering effort by Charnes, Cooper and Rhodes is their focus on decision making by not-for-profits where outcomes inarguably are valuable but not in the customary sense. Their data, similar to the variables involved in the present study, was not freely “weighted by reference to (actual) market prices (and costs)” and required their gathering of optimal estimates for

production coefficients. Furthermore, they discuss its unsuitability for private sector applications, attributing it to the presence of competition. In closing, the gentlemen claim their intent to assess, "resource conservation possibilities, for every DMU(s) with the resources assigned," markedly fitting for the AFMS construct in this study (Charnes, Cooper, & Rhodes, 1978).

Data Envelopment Analysis

According to Dr. Tim Anderson, webmaster of the publicly accessible webpage entitled, "A DEA Website," central tendency is a common statistical approach for comparing efficiency among groups and evaluates members against an "average producer" (http://www.etm.pdx.edu/dea/homedea.html#DEA_Home_Page_ABOUT, 2011). Disinterested in average production and focused on optimizing the current system, the researcher chose instead the methodology that governed the remainder of Anderson's page. Having gained significant momentum following research by Charnes, Cooper and Rhodes (1978), DEA measures efficiency by comparing like DMUs with "only the best" producers. The term, "producer" is synonymous with DMU and represents the MTFs and therefore the Airmen assigned. Their output is reflected both by receipts and sales as well as order lines. DEA's "extreme points" methodological assumptions are consistent with the construct of the AFMS supply chain. For example, this study was conducted with the premise that tools required to complete job tasks were available. Some examples of support mechanisms assumed to be readily available and equal for all producers include: money, manpower, machinery, methods as well as a

supportive management environment. Additionally, 3PL contract support was deemed consistent within each region, as necessary for comparison.

Fundamentally, DEA assumes producers with the same input assets are capable of producing the same output as the best producer provided they are operating in a state of efficiency. Likewise it assumes producers with the same inputs are capable of producing the same output on the same schedule. Finally, data from producers can be merged for both inputs and outputs, particularly useful for this study seeking to optimize aggregate ordering centers. Anderson suggests the core of DEA analysis rests with discovering optimal "virtual" options when the model determines the real system is inefficient. Given the structure of the model, where "one best" is selected and all others are compared against its productivity, the likelihood that several MTFs will not fare well is high. Through application of a Linear Program-based methodology used to compare efficiency of competing firms within a particular industry, Dr. Paul Jensen's Data Envelopment Analysis model assessed the success with which ROFs converted user-defined inputs into outputs (Jensen, 2011).

III. Methodology

Research Question and Focus

Currently, 100% of AFMS facilities operate as stand-alone accounts supported by the PV 3PLs. This means ROFs are assessed their basic charge for services calculated as part of supply prices on an individual basis. This basic fee is directly affected by the addition or elimination of SLEF options currently exercised at the local level (Figure 6).

WARFIGHTER-FOCUSED, GLOBALLY RESPONSIVE, FISCALLY RESPONSIBLE SUPPLY CHAIN LEADERSHIP

GEN IV Award Prices

Item	Cardinal Health	Owens & Minor	GEN III	Comparison
Primary Basic Distribution Fee	**4.05%N, 4.25%W, 4.55%S**	**4.5% (All)**	**4.65%-5.95%**	Better
APC Discount	0-1.50%	0-1.10%	0-1.50%	Same
Alaska DF Add-on	6.00%	7.00%	6.00-7.00%	Same
Hawaii DF Add-on	3.00%	2.50%	3.00-5.50%	Better
Delivery Frequency Discount	.10-.25%	.05-.20%	.05-.60%	Worse
Reduced PV Visits Discount	0%	.05-.15%	.02-.15%	Worse
CONUS On-Site PV Rep.	.46%-5.40%	.40-3.50%	.40%-8.50%	Better
OCONUS On-Site PV Rep.	.27-1.89%	.35-1.50%	.40%-6.30%	Better
USAMMCE On-Site PV Rep.	0.27%	0.35%	0.75%	Better
Increased Delivery within Base	.30-.90%	.35-.85%	.30-.90%	Same
Increased Del outside Base ≤ 25 mi.	.23-.66%	.25-.95%	.20-.95%	Same
Increased Del outside Base > 25 mi.	.28-.70%	.40-1.10%	.25-1.10%	Same
Low Unit of Measure (LUM)	1.00%	4.20-4.80%	4.20-12.05%	Better
Stockless Service	4.20-14.60%	6.00-8.00%	7.60-201.30%	Better
Wound Closure Management	1.59%-4.15%	1.80-2.60%	1.50-7.50%	Better
Cross-Dock Monthly Service Fees	$20,750-$26,000	$14-800-$57,200	$18,000-$60,937	Better
Emergency Order Fee	$168	$65	$65-$145	Worse
Primary WRM Inventory Mgmt	7.25%	10.00%	9.30-20.00%	Better
Secondary WRM Inventory Mgmt	13.25%	12.00%	12.60%-20.00%	Better
PVWRM Distribution Fee	3.50%	5.00%	5.25-6.45%	Better
PVWRM Readiness Manager	$175,000	$157,000	$140,000-150,000	Worse
Back-Up Basic Distribution Fee	**5.75%**	**6.50%**	**8.75-11.55%**	Better

Note: The Items bolded above were used to calculate the Evaluated Offer Value for each PV's Global Region Offer

7

Figure 6. 27 Apr 2011, DLA Summit Brief

The researcher was enlisted to evaluate the efficiency and effectiveness of the current Air Force medical supply chain network configuration. Due to a multitude of external factors

including the complicated nature of the relationship among various inputs and outputs of the medical logistics system, it was unclear whether or not an alternative structure would offer potential for system-wide benefits. Raw cost comparison between the addition of delivery sites (.28-1.10%) contrasted with potential savings from volume discounts (up to 1.50%) suggested the latter would more than offset the former in a 1:1 ratio.

Considered in isolation, this supposition gave little reason to seek out alternative approaches to operations, add to that the absence of conclusive measures of performance. As mentioned in Chapter 2, conventional measures for efficiency, effectiveness and productivity fail to adequately account for the multitude of inputs truly impacting the uniqueness of the medical supply structure. While reviewing the literature in an effort to define productivity measures, it became remarkably evident just how important defining the terms and locating the appropriate model had become. Two extremely common terms describing operational goals in the Air Force, albeit the military, and yet a clear lacking for enterprise-wide meaningful and consistent metrics. This study utilized a model that assigns a weight factor having an equalizing impact on various input units. The robust nature of this particular characteristic of the DEA model allowed for assignment and comparison of efficiency ratings using variables as diverse as manpower authorizations, number of individual line items in a supply order, recovery rate for PV 3PL contractor services as a percentage of annual volume, pipeline or lead time, and annual sales in dollars. From receiving the request for research to the most updated slide presentation and sales data, AFMOA has consistently indicated their support for implementation should results indicate potential for system-wide cost savings. The sponsor asked that the

model indicate optimal hub location(s) within the constraints of the contract. Now in its fourth generation and scheduled to "go live" beginning in December of 2011, the study sought to answer:

> **How efficient and effective are MTFs operating in the current medical supply chain network structure as part of the Medical PV program contract?**

Research Design

While reviewing several journal articles on facility location problems and supply chain network design strategy and similar, a commonality amongst all the approaches emerged. An amassing of conventional measures applicable to industry that did not seem to quite fit the public sector, even less a defense entity providing no and low cost healthcare, created a challenge for the researcher whose primary concern was assessing productivity of the current system. As indicated in Chapter 1, a great many accounts describe inefficiencies from the first Persian Gulf War. Likewise, much is written boasting advancements in the system, some of which were inspired by that same war. What the literature lacks is consistent measures of performance to illustrate what is meant when something is called "efficient" and/or "effective." It was in pursuit of this meaning and while reading numerous narrative accounts and in conversations with AFMOA staff, Grounded Theory principles were applied.

Grounded Theory

Though the vast majority of the research and analysis called for quantitative design, the incorporation of personal accounts, military medical logistics lessons learned since the conflicts in the early 1990s, as well as identification of an applicable model to answer the research questions was rooted in Grounded Theory principles. While collecting relevant background information from the myriad of sources, clear lines of support and opposition regarding research outcomes became evident. The reliance upon, “Narrative data (that) provided additional insights regarding the phenomena of interest,” characterized this dimension of the study as qualitative according to Gay’s Competencies for Analysis and Applications (1996).

Search for a Model

Having satisfactorily defined the variables of interest in AF construct, the search for a model ensued. Conventional approaches for productivity were judged inadequate as was the underlying assumption in traditional transportation problems that related costs to units transported in direct proportion (Diaby, 1991). Though versatile for modeling many supply chain networks, fixed charge characteristics likewise were not applicable (Jawahar & Balaji, 2007). The scope of the study was limited to the government’s two-stage span of control regarding only the MTFs and their respective positions in the AFMS supply chain network.

AFMOA’s request for a tool to illustrate potential for system-wide cost savings via supply chain structure optimization required an assessment of the current state. The

model used as few variables as necessary to adequately assess efficiency and effectiveness. It was unnecessary to apply methods beyond the scope of the sponsor's request and future utility for simulation was desirable. Efficiency related to how well facilities converted manpower and operating costs (inputs) to sales volume and lines of supplies received (outputs) under the current configuration. Effectiveness related to "doing the right thing," and was measured as a function of pipeline or customer wait time. The premise being that while SLEF decisions were not explicitly analyzed, local exercise supported at the AF-level lent it some credence. The study utilized a linear program based methodology created by Dr. Jensen of the University of Texas.

Dr. Jensen's DEA Model

DEAs utility with variable input and output units of measure contribute to its application for purposes of this study. That is, when decision makers are unsure the impact certain inputs have on outcomes and/or how to compare them but are interested in "the lay of the land," DEA is a great place to begin. The model allows comparison of inputs as varied as sales to customer service ratings and square footage to miles of driving, etc. It does not force the user into an, "apples to apples" evaluation. It does however, operate on a few key assumptions:

-Deficiencies and similar negative outcomes make poor output measures
(the model looks for high measures of output for positive productivity)

-Recruitment and similar positive inputs make poor choices as input
(the model operates in an energy conservation mode)

Once the decision to use DEA was made, Dr. Jensen's model quickly rose above others for several reasons. As an educator at University of Texas, he made several of his tools widely accessible and welcomed feedback from the field. The DEA model was formatted as an Excel Add-in with the option of using it or Excel Solver and uses the following general model (Jensen, 2011):

K : The number of DMU's in the analysis, k = 1…K

M : The number of output factors in the analysis, j= 1…M

N : The number of input factors in the analysis, i = 1…N

O_{jk} : The observed value of output j in DMU k

I_{ik} : The observed value of input i in DMU k

μ_j : The weight for output j

$\sigma_{,}$: The weight for input j

The k represents the "index" of the focus DMU in each model run. The separately ran Linear Program model for each k follows this structure:

Where DMU k, $k = 1 \ldots K$

Maximize $E_k = \sum_{j=1}^{M} O_{jk\mu_j}$

$\sum_{I=1}^{N} I_{ik}\sigma_i = 1$

$\sum_{j=1}^{M} O_{jm}\mu_j - \sum_{i=1}^{N} I_{im}\,\sigma_i \leq 0 \; for \; m = 1 \ldots K$

$\mu_j \geq 0 \; for \; j = 1 \ldots M$

$\sigma_i \geq 0 \; for \; i = 1 \ldots N$

All values of O_{jk} and I_{ik} are nonnegative.

The observed output variables for each focus DMU, in turn, are represented as the objective function coefficients. Setting the constraint of the input values equal to one ensures that the weighted sum will equal exactly that. All other constraints are the same and are based on the weights associated with the inputs. They are set up such that efficiency ratings may not exceed 1 or 100% efficiency.

There is also a sensitivity analysis option available that was not utilized for the study. Additionally, Dr. Jensen provided extensive walk-through on his website and links to other related tools and methods. It provided a comprehensive overview of economics, engineering and applicable Operations Research models.

The worksheet that his model was created under was also visually appealing and color-coded. It uses three or four (depending on which format being used) big red click-buttons to change values, solve for efficiencies or build a new model. Clicking the "Solve for Efficiencies" button initiates a linear program for each of the DMUs in a sequential fashion. The solutions from each linear program populate the "Focus DMU Factor Solutions" table along with the "trial weights" range. This returns an efficiency rating for each DMU comparing each to the "one best" producer as explained previously. Changing values or solving an entirely new model can literally be the click of a mouse button. Additionally, cells outlined in bright green indicate they have been computed or calculated already where yellow outline means the cells are configured with formulas. Because the Focus Index indicates the model is solving specifically for one particular DMU, vice efficiency of the entire system, the user has the flexibility to concentrate on one particular DMU by changing values in a single cell (Jensen, 2011).

Data Sources & Format

Variables utilized for the study included number of manpower authorizations, number of individual line items in a given order, annual purchase commitment or basic service rate as a percentage of annual volume, and annual sales in dollars. Data provided by AFMOA was received in Excel format but required extensive sorting and mining. It did not readily lend itself to transfer to the model. There were inconsistencies among the datasets requiring identification of the MTFs to be associated with SRAN vice installation or unit name. The manpower authorizations spreadsheet listed the least number of installations at 73, thereby setting the standard for all others, i.e. manpower was a key input factor for efficiency measure. Similar to SRAN, the Service Level Electives spreadsheet referenced its 93 accounts by DODAAC or Department of Defense Activity Address Codes and contract numbers. Because the SLEF spreadsheet contained far more of the variables of interest for input to the model, that database was used as the template and other data was imported, input, etc.

Blank columns were hidden and row contents abbreviated without distorting meaning, e.g. “Delivery five times per week” was shortened to “Del 5X wkly.” Sponsor confirmed all accounts with active contracts should be considered for cost-savings. However, only accounts with current manpower were used for baseline. Therefore, data provided from installations affected by BRAC like Pope AFB in North Carolina or Brooks AFB account without manpower assigned AFB account with materiel only were not included in the analysis. Upon removal of prepositioned medical supplies and other missions listed on the SLEF document, manpower productivity data inputs were

consistent with the 73 installations provided initially. These were used for productivity baselines and the remainder of the study.

The singular contract-defined constraint, though all pricing related to contract terms, was the assignment of regions for all follow-on modeling beyond the baseline. The contract required additional delivery sites be within the same region. Last year's sales information was available offering an actual comparison vice a hypothetical costing model.

Effectiveness assessed by lead times was sent in Excel spreadsheets by MAJCOM. Each base was represented by its own tab and averages for the month were presented for six additional sources of supply in addition to Medical PV. There were inconsistencies among the spreadsheets and workbooks, e.g. some contained lead times dating back to 2004.

Conclusion

This chapter discussed the chosen methodology, selected after careful consideration for its superior characteristics over other mathematical models. DEA, while not optimal in every situation presented some clear advantages for this research. While considering the multitude of possibilities to apply to the research question, the fact that so many external forces impact the outcome kept resurfacing. Although numerous mathematical models could have been applied for both the productivity assessment and identification of optimal aggregate ordering centers, utility was a huge consideration. DEA lends itself readily to most any input and output values without regard to units of measure, requiring

little to no programming knowledge or experience. Dr. Jensen's model, as an Add-in to the widely circulated Microsoft COTS software adds an even greater element of value. Provided the two assumptions are understood, at the very least adhered to, the model assigns meaningful and equitable efficiency ratings that management can impact by increasing or decreasing the number of variables in the model.

The study sought to answer whether or not a more effective and efficient Air Force Medical Supply Chain network configuration could be realized given current contract constraints and local exercise of Service Level Elective options. The sponsor was interested in a tool that would determine definitively whether and which medical logistics accounts were operating efficiently given the myriad of possible input/output variable units of measure. As mentioned in Chapter 2, traditional measures of efficiency, effectiveness and productivity fail to adequately account for the multitude of inputs significantly impacting cost. This study equalizes units of measure in an attempt to determine if the AFMS could benefit both in garrison and wartime from a better network structure.

IV. Results and Analysis

Initial Findings

The model was initially run using the 73 DMUs referred to extensively in previous chapters. Manpower authorizations and the associated basic service distribution fees served as inputs 1 and 2. Annual line item totals and yearly sales were outputs 1 and 2. Because the sponsor did not indicate any one factor or grouping as more important than any other(s), no weighted factors were assigned and the model treated all factors equally. The table that follows is an excerpt from the data worksheet from that first iteration of the model (Table 2). The “one best producer” was the Mike O’Callaghan Federal Hospital at Nellis AFB, NV which means all others were compared to it. In that comparison, weighted factors were attributed to all others and David Grant Medical Center at Travis AFB, CA and Wilford Hall Medical Center in San Antonio, TX were both found to be 100% efficient by those weighted standards (Table 3). To validate the results of the first model, a second iteration using all DMUs with a different combination of input/output ratio was ran which utilized manpower authorizations and order lines as inputs 1 and 2 and only the basic service distribution fee as an output (Table 4). Those results returned the same, “best producer” with the same two DMUs performing at 100% efficiency once weights were applied. Likewise, the next most efficient were Eglin AFB, FL and Langley AFB, VA.

Table 2. Manpower & Rate to Lines & Sales Global Efficiency

Focus	DEA Efficiency		Trial Weighted Factors Output	Input	Efficiency
HILL AFB, 75TH MG SGL	21%	1	0.26	1.28	20%
TINKER AFB, 654TH MEDICAL GROUP/SGL	17%	2	0.27	1.63	16%
ROBINS AFB, 78TH MG/SGSL	13%	3	0.15	1.29	11%
WRIGHT PATTERSON AFB	72%	4	3.04	6.98	44%
PETERSON AFB, 21ST MEDICAL GROUP/SGSL	28%	5	0.34	1.27	26%
BUCKLEY AIR FORCE BASE	15%	6	0.10	0.72	13%
PATRICK AFB, 45TH MEDICAL GROUP/SGAL	21%	7	0.27	1.37	20%
EDWARDS AFB, 95TH MDSS/SGSL	19%	8	0.15	0.88	18%
LOS ANGELES AFB, 61ST MDSS/SGSL	15%	9	0.07	0.56	13%
EGLIN AFB, 96TH MDSS/SGSL	93%	10	3.23	4.99	65%
HANSCOM AFB, 66TH MG/SGSL	7%	11	0.05	0.73	6%
KEESLER AFB, 81ST MG/SGSL	62%	12	3.90	8.11	48%
SHEPPARD AFB, 82ND MG/SGSL	15%	13	0.32	2.26	14%
COLUMBUS AFB, 14TH MDSS/SGSL	9%	14	0.08	0.89	9%
VANCE AFB, 71ST MG/SGSL	45%	15	0.18	0.50	35%
GOODFELLOW AFB, 17TH MG/SGSL	46%	16	0.15	0.42	34%
WILFORD HALL MEDICAL CENTER	100%	17	5.20	15.15	34%
RANDOLPH AFB, 12TH MDSS/SGSL	34%	18	0.30	0.99	30%
LAUGHLIN AFB, 47TH MDSS/SGSL	15%	19	0.08	0.66	12%
MAXWELL AFB, 42ND MDSS/SGSL	16%	20	0.23	1.45	16%
SCOTT AFB, 375TH MG/SGSL	46%	21	0.59	3.54	17%
HURLBURT FIELD, 16TH MG/SGSL	33%	22	0.40	1.29	31%
CHARLESTON AFB, 437TH MG/SGSL	18%	23	0.18	1.05	17%
ALTUS AFB, 97TH MG/SGSL	9%	24	0.06	0.82	8%
ANDREWS AFB, MALCOLM GROW USAF MED CENTER	36%	25	1.53	6.28	24%
TRAVIS AFB, DAVID GRANT USAF MED CENTER	100%	26	4.82	8.11	60%
LITTLE ROCK AFB, 314TH MG/SGL	21%	27	0.22	1.14	20%
KIRTLAND AFB, 377TH MG/SGSL	9%	28	0.11	1.44	8%
MCCHORD AFB, 62ND MG/SGSL	79%	29	0.07	0.16	41%
MCGUIRE AFB	9%	30	0.19	2.09	9%
LAJES FIELD, 65TH MG/SGSL	1%	31	0.01	0.73	1%
DOVER AFB, 436TH MG/SGSL	13%	32	0.16	1.29	12%
MINOT AFB, 5TH MDSS/SGSL	18%	33	0.15	0.87	17%
OFFUTT AFB, 55TH MDSS/SGSL	17%	34	0.41	2.72	15%
BARKSDALE AFB, 2ND MDSS/SGSL	23%	35	0.24	1.14	21%
VANDENBURG AFB, 30TH MG/SGSL	11%	36	0.09	0.96	10%
F E WARREN AFB, 90TH MG/SGSL	27%	37	0.21	0.87	24%
FAIRCHILD AFB, 92ND MG/SGSL	22%	38	0.22	1.28	17%
MCCONNELL AFB, 22ND MDSS/SGSL	21%	39	0.18	0.96	19%
WHITEMAN AFB, 509TH MG/SGSL	17%	40	0.15	0.96	16%
MALMSTROM AFB, 341ST MG/SGSL	20%	41	0.15	0.79	18%
GRAND FORK AFB, 319TH MDSS/SGSLM	16%	42	0.12	0.87	14%
DYESS AFB, 7TH MG/SGSL	15%	43	0.13	0.98	13%
BEALE AFB, 9TH MG/SGSL	10%	44	0.08	0.96	9%
ELLSWORTH AFB, 28TH MG/SGSL	24%	45	0.19	0.88	22%
LANGLEY AFB, 1ST MG/SGSL	80%	46	2.34	3.38	69%
HOLLOMAN AFB, 49TH MG/SGSL	18%	47	0.19	1.12	17%
SHAW AFB, 20TH MG/SGSL	14%	48	0.18	1.45	13%
SEYMOUR JOHNSON AFB, 4TH MG/SGSL	19%	49	0.22	1.29	17%
MACDILL AFB, 6TH MDSS/SGSL	20%	50	0.49	2.50	20%
TYNDALL AFB, 325TH MG/SGSL	32%	51	0.27	0.97	28%
MOODY AFB, 347TH MG/SGSL	17%	52	0.19	1.21	16%
NELLIS AFB, 99TH MG/SGSL	100%	53	3.57	3.57	100%
CANNON AFB, 27TH MG/SGSL	18%	54	0.18	1.04	17%
DAVIS-MONTHAN AFB, 355TH MDSS/SGSL	19%	55	0.22	1.44	15%
LUKE AFB, 56TH MDSS/SGSL	18%	56	0.30	1.76	17%
MOUNTAIN HOME AFB, 366TH MG/SGSL	37%	57	0.54	1.52	36%
ELMENDORF AFB, 3RD MDSS/SGSL	44%	58	2.50	5.65	44%
EIELSON AFB, 354TH MG/SGSL	13%	59	0.10	1.01	10%
YOKOTA AB, 374TH MG/SGSL	12%	60	0.44	5.62	8%
MISAWA AB, 35TH MG/SGSL	18%	61	0.34	2.09	16%
ANDERSEN AFB, 36TH MG/SGSL	19%	62	0.17	0.96	17%
HICKAM AFB, 15TH MG/SGSL	19%	63	0.20	1.18	17%
KADENA AB, 18TH MDSS/SGSL	28%	64	0.50	2.97	17%
KUNSAN AB, 8TH MDSS/SGSL	6%	65	0.14	2.16	6%
OSAN AB, 51ST MG/SGSL	15%	66	0.37	3.04	12%
RAF LAKENHEATH, 48TH MDSS/SGSL	21%	67	0.71	4.76	15%
SPANGDAHLEM AB, 52ND MDSS/SGSL	6%	68	0.12	2.10	6%
RAMSTEIN AB, 86TH MG/SGSL	3%	69	0.10	5.06	2%
INCIRLIK AB, 39TH MED GROUP/SGSL	3%	70	0.09	3.86	2%
AVIANO AB, 31ST MDSS/SGSL	15%	71	0.25	2.01	12%
USAF ACADEMY, 10TH MG/SGSL	53%	72	1.22	2.48	49%
BOLLING AFB, 11TH MDOS/SGSL	14%	73	0.09	0.73	13%

Table 3. Manpower & Rate to Lines Global Efficiency

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WRIGHT PATTERSON AFB	72%	4	3.01	6.97	43%
PETERSON AFB, 21ST MEDICAL GROUP/SGSL	28%	5	0.35	1.29	27%
BUCKLEY AIR FORCE BASE	15%	6	0.10	0.74	13%
PATRICK AFB, 45TH MEDICAL GROUP/SGAL	21%	7	0.28	1.39	20%
EDWARDS AFB, 95TH MDSS/SGSL	19%	8	0.16	0.90	18%
LOS ANGELES AFB, 61ST MDSS/SGSL	15%	9	0.08	0.58	13%
EGLIN AFB, 96TH MDSS/SGSL	86%	10	3.18	4.99	64%
HANSCOM AFB, 66TH MG/SGSL	7%	11	0.05	0.75	7%
KEESLER AFB, 81ST MG/SGSL	62%	12	3.90	8.12	48%
SHEPPARD AFB, 82ND MG/SGSL	15%	13	0.33	2.28	15%
COLUMBUS AFB, 14TH MDSS/SGSL	9%	14	0.08	0.91	9%
VANCE AFB, 71ST MG/SGSL	45%	15	0.19	0.53	36%
GOODFELLOW AFB, 17TH MG/SGSL	46%	16	0.15	0.45	34%
WILFORD HALL MEDICAL CENTER	100%	17	4.86	15.10	32%
RANDOLPH AFB, 12TH MDSS/SGSL	34%	18	0.31	1.01	31%
LAUGHLIN AFB, 47TH MDSS/SGSL	15%	19	0.09	0.69	12%
MAXWELL AFB, 42ND MDSS/SGSL	16%	20	0.23	1.47	16%
SCOTT AFB, 375TH MG/SGSL	17%	21	0.51	3.54	14%
HURLBURT FIELD, 16TH MG/SGSL	33%	22	0.41	1.31	31%
CHARLESTON AFB, 437TH MG/SGSL	18%	23	0.18	1.07	17%
ALTUS AFB, 97TH MG/SGSL	9%	24	0.07	0.85	8%
ANDREWS AFB, MALCOLM GROW USAF MED CENTER	36%	25	1.56	6.28	25%
TRAVIS AFB, DAVID GRANT USAF MED CENTER	100%	26	4.72	8.09	58%
LITTLE ROCK AFB, 314TH MG/SGL	21%	27	0.23	1.15	20%
KIRTLAND AFB, 377TH MG/SGSL	8%	28	0.11	1.45	7%
MCCHORD AFB, 62ND MG/SGSL	79%	29	0.07	0.18	37%
MCGUIRE AFB	9%	30	0.19	2.10	9%
LAJES FIELD, 65TH MG/SGSL	1%	31	0.01	0.75	1%
DOVER AFB, 436TH MG/SGSL	13%	32	0.16	1.31	12%
MINOT AFB, 5TH MDSS/SGSL	18%	33	0.15	0.88	17%
OFFUTT AFB, 55TH MDSS/SGSL	17%	34	0.42	2.73	15%
BARKSDALE AFB, 2ND MDSS/SGSL	23%	35	0.25	1.16	22%
VANDENBURG AFB, 30TH MG/SGSL	11%	36	0.10	0.98	10%
F E WARREN AFB, 90TH MG/SGSL	27%	37	0.22	0.89	25%
FAIRCHILD AFB, 92ND MG/SGSL	17%	38	0.22	1.29	17%
MCCONNELL AFB, 22ND MDSS/SGSL	21%	39	0.19	0.98	19%
WHITEMAN AFB, 509TH MG/SGSL	17%	40	0.16	0.98	16%
MALMSTROM AFB, 341ST MG/SGSL	20%	41	0.15	0.81	19%
GRAND FORK AFB, 319TH MDSS/SGSLM	16%	42	0.13	0.89	15%
DYESS AFB, 7TH MG/SGSL	15%	43	0.13	1.00	13%
BEALE AFB, 9TH MG/SGSL	10%	44	0.09	0.98	9%
ELLSWORTH AFB, 28TH MG/SGSL	24%	45	0.20	0.90	22%
LANGLEY AFB, 1ST MG/SGSL	80%	46	2.41	3.39	71%
HOLLOMAN AFB, 49TH MG/SGSL	18%	47	0.19	1.13	17%
SHAW AFB, 20TH MG/SGSL	14%	48	0.19	1.47	13%
SEYMOUR JOHNSON AFB, 4TH MG/SGSL	19%	49	0.24	1.30	18%
MACDILL AFB, 6TH MDSS/SGSL	20%	50	0.50	2.51	20%
TYNDALL AFB, 325TH MG/SGSL	32%	51	0.29	0.99	29%
MOODY AFB, 347TH MG/SGSL	17%	52	0.19	1.22	16%
NELLIS AFB, 99TH MG/SGSL	100%	53	3.58	3.59	100%
CANNON AFB, 27TH MG/SGSL	18%	54	0.18	1.06	17%
DAVIS-MONTHAN AFB, 355TH MDSS/SGSL	15%	55	0.21	1.45	15%
LUKE AFB, 56TH MDSS/SGSL	18%	56	0.31	1.77	17%
MOUNTAIN HOME AFB, 366TH MG/SGSL	37%	57	0.56	1.53	37%
ELMENDORF AFB, 3RD MDSS/SGSL	44%	58	2.52	5.68	44%
EIELSON AFB, 354TH MG/SGSL	13%	59	0.11	1.05	10%
YOKOTA AB, 374TH MG/SGSL	12%	60	0.44	5.61	8%
MISAWA AB, 35TH MG/SGSL	16%	61	0.34	2.10	16%
ANDERSEN AFB, 36TH MG/SGSL	19%	62	0.17	0.98	17%
HICKAM AFB, 15TH MG/SGSL	19%	63	0.21	1.21	17%
KADENA AB, 18TH MDSS/SGSL	18%	64	0.48	2.98	16%
KUNSAN AB, 8TH MDSS/SGSL	6%	65	0.14	2.17	6%
OSAN AB, 51ST MG/SGSL	15%	66	0.37	3.05	12%
RAF LAKENHEATH, 48TH MDSS/SGSL	18%	67	0.69	4.77	15%
SPANGDAHLEM AB, 52ND MDSS/SGSL	6%	68	0.12	2.11	6%
RAMSTEIN AB, 86TH MG/SGSL	3%	69	0.10	5.06	2%
INCIRLIK AB, 39TH MED GROUP/SGSL	3%	70	0.09	3.86	2%
AVIANO AB, 31ST MDSS/SGSL	12%	71	0.25	2.03	12%
USAF ACADEMY, 10TH MG/SGSL	53%	72	1.23	2.49	50%
BOLLING AFB, 11TH MDOS/SGSL	14%	73	0.09	0.75	12%

Global Efficiency

As stated previous, DEA makes its comparison based on the “one best” producer in the group and calculates efficiencies awarding weights based on the principle that all members are equally capable of performing. While every organization has different dynamics, the measurements of interest, e.g. order lines, manpower authorizations, service delivery fees, etc. were gathered in a purely objective manner without regard for mission, major command, previous experience with the base, etc. Additionally, having gathered data from May 2010-April 2011, it is quite conceivable many, if not all of the DMUs experienced some kind of employee turnover either within their flights or in leadership.

As Charnes, Cooper and Rhodes imply in their work, the myth of identical firms does not excuse society from its responsibility to conserve resources and assess programs (1979). The first two iterations indicate Nellis is most efficiently utilizing its manpower and distribution fee to produce sales in the form of lines ordered. Once Nellis was deemed the one best producer and others were assessed weights, Wilford Hall and David Grant both achieved maximum efficiency scores as well indicating they also are efficiently utilizing their manpower and distribution fees to that same end. They were followed most closely by the 96th MDG at Eglin rating at 93% and the 1st MDG at Langley who were able to reach 80% DEA efficiency with weighted measure. The vast majority of the AFMS rated well below 30% on this first measure.

The researcher ran the model the second time removing annual sales totals, not only for the validity and reliability proposition, but due to the dual effect the distribution

rate might have on the model. Recall basic service distribution rates are calculated in as part of the product price, therefore DMUs might twice be penalized for paying higher rates, especially if unable to qualify for discounts and/or if not placing numerous line orders. Though the top producers in the second run were identical, the sum total of raw efficiency scores was about 18% apart. The difference between the DEA efficiencies was much greater at 64.

In the interest of reliability as well as validity, before proceeding to the regional break-outs, the researcher performed one more global run removing both the manpower and sales variables. The justification being the perception that size might be “pulling” the efficiency rating to favor the larger MTFs, this final global run was titled, “Lines2Rate” and included individually ordered lines and the basic distribution rate. This final run returned a different “one best” than the prior two, and had far less front runners than its counterparts. Those results are also included (Table 4).

Table 4. Lines to Rate Global Efficiency

Focus	DEA Efficiency		Trial Weighted Factors Output	Input	Efficiency
HILL AFB, 75TH MG SGL	6%	1	0.05	0.88	6%
TINKER AFB, 654TH MEDICAL GROUP/SGL	4%	2	0.05	1.25	4%
ROBINS AFB, 78TH MG/SGSL	3%	3	0.03	0.98	3%
WRIGHT PATTERSON AFB	60%	4	0.59	0.98	60%
PETERSON AFB, 21ST MEDICAL GROUP/SGSL	9%	5	0.07	0.81	9%
BUCKLEY AIR FORCE BASE	2%	6	0.02	0.88	2%
PATRICK AFB, 45TH MEDICAL GROUP/SGAL	5%	7	0.05	1.02	5%
EDWARDS AFB, 95TH MDSS/SGSL	4%	8	0.03	0.88	4%
LOS ANGELES AFB, 61ST MDSS/SGSL	2%	9	0.02	0.88	2%
EGLIN AFB, 96TH MDSS/SGSL	55%	10	0.63	1.15	55%
HANSCOM AFB, 66TH MG/SGSL	1%	11	0.01	0.99	1%
KEESLER AFB, 81ST MG/SGSL	38%	12	0.77	2.02	38%
SHEPPARD AFB, 82ND MG/SGSL	6%	13	0.07	1.09	6%
COLUMBUS AFB, 14TH MDSS/SGSL	1%	14	0.02	1.03	1%
VANCE AFB, 71ST MG/SGSL	3%	15	0.04	1.16	3%
GOODFELLOW AFB, 17TH MG/SGSL	3%	16	0.03	1.16	3%
WILFORD HALL MEDICAL CENTER	100%	17	0.96	0.96	100%
RANDOLPH AFB, 12TH MDSS/SGSL	5%	18	0.06	1.17	5%
LAUGHLIN AFB, 47TH MDSS/SGSL	1%	19	0.02	1.16	1%
MAXWELL AFB, 42ND MDSS/SGSL	5%	20	0.05	1.02	5%
SCOTT AFB, 375TH MG/SGSL	10%	21	0.10	1.03	10%
HURLBURT FIELD, 16TH MG/SGSL	8%	22	0.08	0.99	8%
CHARLESTON AFB, 437TH MG/SGSL	4%	23	0.04	0.99	4%
ALTUS AFB, 97TH MG/SGSL	1%	24	0.01	1.16	1%
ANDREWS AFB, MALCOLM GROW USAF MED CENTER	24%	25	0.31	1.26	24%
TRAVIS AFB, DAVID GRANT USAF MED CENTER	87%	26	0.93	1.06	87%
LITTLE ROCK AFB, 314TH MG/SGL	4%	27	0.05	1.05	4%
KIRTLAND AFB, 377TH MG/SGSL	2%	28	0.02	0.88	2%
MCCHORD AFB, 62ND MG/SGSL	1%	29	0.01	0.89	1%
MCGUIRE AFB	4%	30	0.04	0.99	4%
LAJES FIELD, 65TH MG/SGSL	0%	31	0.00	1.04	0%
DOVER AFB, 436TH MG/SGSL	3%	32	0.03	1.03	3%
MINOT AFB, 5TH MDSS/SGSL	4%	33	0.03	0.77	4%
OFFUTT AFB, 55TH MDSS/SGSL	9%	34	0.08	0.88	9%
BARKSDALE AFB, 2ND MDSS/SGSL	5%	35	0.05	1.09	5%
VANDENBURG AFB, 30TH MG/SGSL	2%	36	0.02	0.88	2%
F E WARREN AFB, 90TH MG/SGSL	5%	37	0.04	0.81	5%
FAIRCHILD AFB, 92ND MG/SGSL	5%	38	0.04	0.87	5%
MCCONNELL AFB, 22ND MDSS/SGSL	4%	39	0.04	0.88	4%
WHITEMAN AFB, 509TH MG/SGSL	4%	40	0.03	0.88	4%
MALMSTROM AFB, 341ST MG/SGSL	4%	41	0.03	0.81	4%
GRAND FORK AFB, 319TH MDSS/SGSLM	3%	42	0.03	0.81	3%
DYESS AFB, 7TH MG/SGSL	2%	43	0.03	1.09	2%
BEALE AFB, 9TH MG/SGSL	2%	44	0.02	0.88	2%
ELLSWORTH AFB, 28TH MG/SGSL	4%	45	0.04	0.88	4%
LANGLEY AFB, 1ST MG/SGSL	44%	46	0.47	1.09	44%
HOLLOMAN AFB, 49TH MG/SGSL	4%	47	0.04	0.88	4%
SHAW AFB, 20TH MG/SGSL	4%	48	0.04	0.98	4%
SEYMOUR JOHNSON AFB, 4TH MG/SGSL	5%	49	0.05	0.97	5%
MACDILL AFB, 6TH MDSS/SGSL	10%	50	0.10	1.03	10%
TYNDALL AFB, 325TH MG/SGSL	6%	51	0.06	0.99	6%
MOODY AFB, 347TH MG/SGSL	4%	52	0.04	0.97	4%
NELLIS AFB, 99TH MG/SGSL	50%	53	0.71	1.41	50%
CANNON AFB, 27TH MG/SGSL	4%	54	0.03	0.88	4%
DAVIS-MONTHAN AFB, 355TH MDSS/SGSL	5%	55	0.04	0.88	5%
LUKE AFB, 56TH MDSS/SGSL	7%	56	0.06	0.88	7%
MOUNTAIN HOME AFB, 366TH MG/SGSL	13%	57	0.11	0.88	13%
ELMENDORF AFB, 3RD MDSS/SGSL	22%	58	0.50	2.30	22%
EIELSON AFB, 354TH MG/SGSL	1%	59	0.02	2.30	1%
YOKOTA AB, 374TH MG/SGSL	9%	60	0.09	0.98	9%
MISAWA AB, 35TH MG/SGSL	7%	61	0.07	0.98	7%
ANDERSEN AFB, 36TH MG/SGSL	4%	62	0.03	0.90	4%
HICKAM AFB, 15TH MG/SGSL	3%	63	0.04	1.52	3%
KADENA AB, 18TH MDSS/SGSL	10%	64	0.09	0.98	10%
KUNSAN AB, 8TH MDSS/SGSL	3%	65	0.03	0.89	3%
OSAN AB, 51ST MG/SGSL	8%	66	0.07	0.89	8%
RAF LAKENHEATH, 48TH MDSS/SGSL	11%	67	0.14	1.26	11%
SPANGDAHLEM AB, 52ND MDSS/SGSL	2%	68	0.02	1.04	2%
RAMSTEIN AB, 86TH MG/SGSL	2%	69	0.02	1.06	2%
INCIRLIK AB, 39TH MED GROUP/SGSL	2%	70	0.02	1.04	2%
AVIANO AB, 31ST MDSS/SGSL	5%	71	0.05	1.03	5%
USAF ACADEMY, 10TH MG/SGSL	27%	72	0.24	0.89	27%
BOLLING AFB, 11TH MDOS/SGSL	2%	73	0.02	1.00	2%

Data Alibis and Additional Analysis

While preparing to break data out into respective Tricare Regional Business Office Regions (TRBOs) and continuing to collect other data, a couple of issues came to light that resulted in changing the initial scope of the study. The initial manpower document was missing a SRAN for McChord AFB appearing to be an oversight. Thus, the researcher located the information from other sources and reconciled the data. It soon became apparent however, that while McChord could certainly benefit from the efficiency rating schemes already conducted, in the future similar analysis would likely be impossible. After reviewing the pipeline documents with great scrutiny, data for McChord could not be located. Upon contacting AFMOA directly, it was reported that the DMLSS server at McChord had been deactivated some time ago and the base was subsequently serviced out of Fairchild AFB, WA.

Additionally, while mining the raw data from AFMOA's pipeline reports it also became clear that OCONUS ROFs would not make good candidates for the DEA model's effectiveness measure. The SLEF data provided by the PV lacked a delivery frequency for those bases located overseas. As discussed previously, PV does not provide the option for additional delivery sites to OCONUS in Gen IV. However the lack of availability had no bearing on the intent of this study to assess whether the AFMS was operating effectively given the resources at hand. The more recent discovery though, removed OCONUS from the pool of data for effectiveness measure because of the 1:1 input/output ratio; it simply would not be feasible.

Effectiveness by Region

As a function of managerial decision making, effectiveness is assessed by region using a researcher adaptation of Dr. Jensen's DEA model. Average lead times were provided by AFMOA for each MTF for the past couple of years. Since lead times are directly related to customer wait times and consequently satisfaction and other "soft" measures, mentioned briefly, the researcher utilized this input to assess productivity related to the presented definition of effectiveness. Particularly complex, was selection of an appropriate output measure that would assess decision making effectiveness as described by Charnes, Cooper, and Rhodes (1978), directly connected to delivery frequency as well as consistent with the basic assumptions required for DEA input, i.e. that it be goaled towards a high value.

Originally, the plan had been to compare lead time with delivery frequency; the obvious contradiction with the DEA model, that both would be a minimization model. The model also restricts values to greater than zero integers making the delivery frequency discounts seemingly ineligible as well. Following the logic that a discount is a positive outcome and DEA is a measure of positive outcomes, the researcher modified the delivery frequency column. It was originally formatted with negative integers, not transferrable to Dr. Jensen's model. Furthermore the amount of many of the discounts, e.g. .05-.45% was not significant enough to instigate a weighting in Dr. Jensen's model. Therefore, the researcher took an absolute value and multiplied the discounts by ten, e.g. resulting in range .5-4.5. The numerous accounts with zero discount for delivery frequency made this output measure insufficient to measure effectiveness.

A Combined Model- Efficiency and Effectiveness

As indicated previously, distribution rate directly impacts sales because of the effect on pricing, thereby making annual sales and receipts poor choices as output measures. Though the potential to influence the model is unclear, this "known" impact on pricing disqualifies the latter as a satisfactory effectiveness measure. More appropriately then, is the annual total of lines ordered having little to nothing to do with pricing and everything to do with production and output. Effectiveness as operationalized in Chapter 2, involves leadership management of valued resources while minimizing waste. Arguably the most valuable resource any organization has is its people; manpower authorizations make a suitable input to this measure of effectiveness.

Appearing very similar to either of the first two global measures for efficiency, the discriminating characteristic of this final series involves the exclusion of sales and receipts as previously mentioned as well as any 3PL fees. The researcher opted to combine the efficiency and effectiveness objectives upon realizing both the robustness of certain aspects of DEA, along with its limitations. The key to incorporating effectiveness as part of the efficiency assessment was ensuring some aspect of judgment was present. Manpower as an input where order lines are an output makes that connection, as does pipeline time with regard to active customer service.

Although the study initially planned to run two series of 13 in addition to the global run for 27 in total, the final result included 15 (11 regional models with three globally). The last series entitled Manpower and Leadtime to Lines was ran for each region by TRBO and follows:

Results by Region

Similar to global results, larger DMU returns a higher efficiency rating in this first run (Table 5) of the DEA for TRBO 1. Andrews has an average lead time of 8.48 days, not significantly greater than the other bases in the region. Consider the number of manpower assigned at 77. However, three times the amount of manning is hardly the equivalent of ten times the amount of orders processed at nearly 120K annually.

Table 5. TRBO 1 DEA Efficiency

		OrderLines	Manpower	Lead Time	Include			DEA		Trial Weighted Factors		
	DMU	Output 1	Input 1	Input 2	DMU		Focus	Efficiency		Output	Input	Efficiency
1	DMU 1	374	8	6.33	1	1	DMU 1	HANSCOM AFB, 66TH MG/SGSL	1	0.18	0.59	30%
2	DMU 2	11956	77	8.48	1	2	DMU 2	ANDREWS AFB, MALCOLM GROW USAF MED CENTER	2	5.69	5.69	100%
3	DMU 3	1424	25	7.67	1	3	DMU 3	MCGUIRE AFB	3	0.68	1.85	37%
4	DMU 4	1231	15	8.97	1	4	DMU 4	DOVER AFB, 436TH MG/SGSL	4	0.59	1.11	53%
5	DMU 5	716	8	6.16	1	5	DMU 5	BOLLING AFB, 11TH MDOS/SGSL	5	0.34	0.59	58%
Incl Factor:		1	1	1								

Of the two DMUs in TRBO 2 (Table 6), Langley has the greater efficiency rating and an average lead time of 5.85 days, lower than any DMU in TRBO 1. The comparison is raised because Langley receives deliveries daily.

Table 6. TRBO 2 DEA Efficiency

		OrderLines	Manpower	Lead Time	Include			DEA		Trial Weighted Factors		
	DMU	Output 1	Input 1	Input 2	DMU		Focus	Efficiency		Output	Input	Efficiency
1	DMU 1	18431	41	5.85	1	1	DMU 1	LANGLEY AFB, 1ST MG/SGSL	1	1.87	1.87	100%
2	DMU 2	1817	15	9.18	1	2	DMU 2	SEYMOUR JOHNSON AFB, 4TH MG/SGSL	2	0.18	0.68	27%
Incl Factor:		1	1	1								

Interestingly, in TRBO 3 (Table 7) Patrick AFB does not have the most Airmen authorized or the highest number of lines and yet are rated most efficient. They are close to Robins, Shaw, and Moody in manpower and process significantly greater lines, nearly twice as many as Robins AFB. Their average lead time is nearly half of Shaw. These results do not suggest their capability for hub consideration, but do offer possibility that smaller gains might be achieved at accounts operating at such efficiency. Note MacDill AFB, the largest in this region, closely behind at 97% efficiency.

Table 7. TRBO 3 DEA Efficiency

	DMU	OrderLines Output 1	Manpower Input 1	Lead Time Input 2	Include DMU		Focus	DEA Efficiency		Trial Weighted Factors Output	Input	Efficiency
1	DMU 1	1113	15	9.34	1	1	DMU 1	ROBINS AFB, 78TH MG/SGSL	1	0.53	0.95	56%
2	DMU 2	2116	16	5.88	1	2	DMU 2	PATRICK AFB, 45TH MEDICAL GROUP/SGAL	2	1.01	1.01	100%
3	DMU 3	1408	12	11.68	1	3	DMU 3	CHARLESTON AFB, 437TH MG/SGSL	3	0.67	0.76	88%
4	DMU 4	1479	17	11.18	1	4	DMU 4	SHAW AFB, 20TH MG/SGSL	4	0.70	1.07	66%
5	DMU 5	3847	30	5.02	1	5	DMU 5	MACDILL AFB, 6TH MDSS/SGSL	5	1.83	1.88	97%
6	DMU 6	1480	14	6.5	1	6	DMU 6	MOODY AFB, 347TH MG/SGSL	6	0.70	0.88	80%
Incl Factor:		1	1	1								

TRBO 4 (Table 8) has two "potential" aggregate order centers in Eglin and Keesler based on Chapter 2 requisites. For their efficiency rating, however, Eglin is the clear "one best" in the region in spite of Keesler's 39% greater manning. With 38 more authorizations, Keesler reportedly only processed an additional 5K more lines. The efficiency lag is not slight as was the case in TRBO 3

Table 8. TRBO 4 DEA Efficiency

		OrderLines Output 1	Manpower Input 1	Lead Time Input 2	Include DMU		Focus	DEA Efficiency		Trial Weighted Factors Output	Input	Efficiency
1	DMU 1	24331	61	5.08	1	1	DMU 1	EGLIN AFB, 96TH MDSS/SGSL	1	3.52	3.52	100%
2	DMU 2	29805	99	4.26	1	2	DMU 2	KEESLER AFB, 81ST MG/SGSL	2	4.31	5.66	76%
3	DMU 3	595	10	11.03	1	3	DMU 3	COLUMBUS AFB, 14TH MDSS/SGSL	3	0.09	0.72	12%
4	DMU 4	1777	17	12.78	1	4	DMU 4	MAXWELL AFB, 42ND MDSS/SGSL	4	0.26	1.14	23%
5	DMU 5	3138	15	11.45	1	5	DMU 5	HURLBURT FIELD, 16TH MG/SGSL	5	0.45	1.00	45%
6	DMU 6	2209	11	5.08	1	6	DMU 6	TYNDALL AFB, 325TH MG/SGSL	6	0.32	0.69	46%
Incl Factor:		1	1	1								

Between Scott AFB and Wright-Patterson AFB in TRBO 5 (Table 9), Wright-Patterson is rated more efficient with a n average lead time for 3.95 days. Though eliminated during initial rounds of data compilation because of its lack of manpower authorizations, the lab at Wright-Patterson seems a good account to consider for order aggregation. It would be eligible for same installation pricing at less than 25 miles.

Table 9. TRBO 5 DEA Efficiency

		Outputs OrderLines Output 1	Inputs Manpower Input 1	Lead Time Input 2	Include DMU		Focus	DEA Efficiency		Trial Weighted Factors Output	Input	Efficiency
1	DMU 1	23039	86	3.95	1	1	DMU 1	WRIGHT PATTERSON AFB	1	1.50	1.50	100%
2	DMU 2	3890	43	8.75	1	2	DMU 2	SCOTT AFB, 375TH MG/SGSL	2	0.25	0.75	34%
Incl Factor:		1	1	1								

TRBO 6 (Figure 10) with 11 DMUs is one of the largest regions serviced by PV. Again, a smaller facility has the greatest efficiency with low average lead time and making impressive use of its assets. Once again, this does not suggest Vance would be considered an aggregate order center. It does however, support justification to remain a

stand-alone ROF should system-wide implementation be considered. In this region, Wilford Hall Medical Center is the only DMU with services and manning to support the surrounding area. In spite of its impressive 3.43 average lead time, it rated 83% efficiency both because of its manpower authorizations and larger output, but greater weight was placed on manpower as indicated in the model

Table 10. TRBO 6 DEA Efficiency

		Order Lines	Manpower	Lead Time	Include			DEA		Trial Weighted Factors		
	DMU	Output 1	Input 1	Input 2	DMU		Focus	Efficiency		Output	Input	Efficiency
1	DMU 1	2097	19	4.69	1	1	DMU 1	TINKER AFB, 654TH MEDICAL GROUP/SGL	1	0.81	1.85	44%
2	DMU 2	2558	27	4.77	1	2	DMU 2	SHEPPARD AFB, 82ND MG/SGSL	2	0.99	2.58	38%
3	DMU 3	1437	5	4.3	1	3	DMU 3	VANCE AFB, 71ST MG/SGSL	3	0.55	0.55	100%
4	DMU 4	1168	4	6.48	1	4	DMU 4	GOODFELLOW AFB, 17TH MG/SGSL	4	0.45	0.51	88%
5	DMU 5	37165	188	3.43	1	5	DMU 5	WILFORD HALL MEDICAL CENTER	5	14.34	17.30	83%
6	DMU 6	2375	11	7.15	1	6	DMU 6	RANDOLPH AFB, 12TH MDSS/SGSL	6	0.92	1.17	78%
7	DMU 7	651	7	7.08	1	7	DMU 7	LAUGHLIN AFB, 47TH MDSS/SGSL	7	0.25	0.80	31%
8	DMU 8	523	9	5.22	1	8	DMU 8	ALTUS AFB, 97TH MG/SGSL	8	0.20	0.94	21%
9	DMU 9	1755	13	5	1	9	DMU 9	LITTLE ROCK AFB, 314TH MG/SGL	9	0.68	1.30	52%
10	DMU 10	1913	13	6.02	1	10	DMU 10	BARKSDALE AFB, 2ND MDSS/SGSL	10	0.74	1.33	56%
11	DMU 11	1021	11	6.75	1	11	DMU 11	DYESS AFB, 7TH MG/SGSL	11	0.39	1.16	34%
Incl Factor:		1	1	1								

The largest region, TRBO 7&8 (Table 11) rates Nellis AFB as the most efficient, similar to the first two global measures. Nellis averaged 3.69 days lead time in the past year processing over 27K lines. Comparatively, that is just 2K less than Keesler with half as many Airmen assigned. It is also 2K more than Eglin with 20 less Airmen. Of note, however and though not “officially” part of this study, the Mike O’Callaghan Federal Hospital is part of a joint venture between the DoD and the Veterans Administration with a few full-time staff members supporting logistics functions who are

not accounted for on the manpower document due to their role at the facility. This does not even begin to account for their efficiency and effectiveness rating, however

Table 11. TRBO 7&8

		Order Lines	Manpower	Lead Time	Include			DEA		Trial Weighted Factors		
	DMU	Output 1	Input 1	Input 2	DMU		Focus	Efficiency		Output	Input	Efficiency
1	DMU 1	2023	15	6.12	1	1	DMU 1	HILL AFB, 75TH MG SGL	1	0.24	1.12	21%
2	DMU 2	2671	15	4.7	1	2	DMU 2	PETERSON AFB, 21ST MEDICAL GROUP/SGSL	2	0.31	1.12	28%
3	DMU 3	746	8	6.59	1	3	DMU 3	BUCKLEY AIR FORCE BASE	3	0.09	0.60	15%
4	DMU 4	825	17	6.06	1	4	DMU 4	KIRTLAND AFB, 377TH MG/SGSL	4	0.10	1.27	8%
5	DMU 5	1150	10	7.75	1	5	DMU 5	MINOT AFB, 5TH MDSS/SGSL	5	0.13	0.75	18%
6	DMU 6	3194	33	5.47	1	6	DMU 6	OFFUTT AFB, 55TH MDSS/SGSL	6	0.37	2.46	15%
7	DMU 7	1712	10	5.82	1	7	DMU 7	F E WARREN AFB, 90TH MG/SGSL	7	0.20	0.75	27%
8	DMU 8	1443	11	4.96	1	8	DMU 8	MCCONNELL AFB, 22ND MDSS/SGSL	8	0.17	0.82	21%
9	DMU 9	1225	11	6.61	1	9	DMU 9	WHITEMAN AFB, 509TH MG/SGSL	9	0.14	0.82	17%
10	DMU 10	1163	9	6.36	1	10	DMU 10	MALMSTROM AFB, 341ST MG/SGSL	10	0.14	0.67	20%
11	DMU 11	998	10	7.16	1	11	DMU 11	GRAND FORK AFB, 319TH MDSS/SGSLM	11	0.12	0.75	16%
12	DMU 12	1521	10	6.63	1	12	DMU 12	ELLSWORTH AFB, 28TH MG/SGSL	12	0.18	0.75	24%
13	DMU 13	1453	13	7.09	1	13	DMU 13	HOLLOMAN AFB, 49TH MG/SGSL	13	0.17	0.97	18%
14	DMU 14	27382	43	3.69	1	14	DMU 14	NELLIS AFB, 99TH MG/SGSL	14	3.21	3.21	100%
15	DMU 15	1353	12	5.92	1	15	DMU 15	CANNON AFB, 27TH MG/SGSL	15	0.16	0.90	18%
16	DMU 16	1638	17	6.74	1	16	DMU 16	DAVIS-MONTHAN AFB, 355TH MDSS/SGSL	16	0.19	1.27	15%
17	DMU 17	2354	21	4.63	1	17	DMU 17	LUKE AFB, 56TH MDSS/SGSL	17	0.28	1.57	18%
18	DMU 18	4297	18	4.39	1	18	DMU 18	MOUNTAIN HOME AFB, 366TH MG/SGSL	18	0.50	1.34	37%
19	DMU 19	9442	30	4.36	1	19	DMU 19	USAF ACADEMY, 10TH MG/SGSL	19	1.11	2.24	49%
Incl Factor:		1	1	1								

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TRBO 9 (Table 12) ranks Edwards as most efficient. In this particular case, none of the DMUs meets the criteria for order aggregation centers as defined in Chapter 1. Even with just over 1K orders for the past year, the average lead time was nearly ten days at 9.55. Unfortunately, contract terms prevent the addition of delivery sites outside of individual regions. Given the Gen IV specifications where both PVs are eligible for primary and back-up, whether or not that will change remains to be seen. For now though, that possibility is outside of scope for this study.

Table 12. TRBO 9 DEA Efficiency

	DMU	Order Lines Output 1	Manpower Input 1	Lead Time Input 2	Include DMU		Focus	DEA Efficiency		Trial Weighted Factors Output	Input	Efficiency
1	DMU 1	1236	10	9.55	1	1	DMU 1	EDWARDS AFB, 95TH MDSS/SGSL	1	1.35	1.35	100%
2	DMU 2	587	6	8.12	1	2	DMU 2	LOS ANGELES AFB, 61ST MDSS/SGSL	2	0.64	0.93	69%
3	DMU 3	756	11	6.88	1	3	DMU 3	VANDENBURG AFB, 30TH MG/SGSL	3	0.83	1.31	63%
Incl Factor:		1	1	1								

Containing only Travis and Beale AFB in TRBO 10 (Table 13), Travis was rated the more efficient of the two. Even with less than 1K lines annually and nearly a dozen manpower authorizations, Beale has an average lead time of 6.43 days indicating possible issues with efficiency and effectiveness

Table 13. TRBO 10 DEA Efficiency

	DMU	Order Lines Output 1	Manpower Input 1	Lead Time Input 2	Include DMU		Focus	DEA Efficiency		Trial Weighted Factors Output	Input	Efficiency
1	DMU 1	36119	100	4.38	1	1	DMU 1	TRAVIS AFB, DAVID GRANT USAF MED CENTER	1	5.05	5.05	100%
2	DMU 2	681	11	6.43	1	2	DMU 2	BEALE AFB, 9TH MG/SGSL	2	0.10	0.56	17%
Incl Factor:		1	1	1								

Because McChord is serviced by Fairchild it was not included in this iteration of efficiency and effectiveness modeling although it does fall within TRBO 11/TRBO 11-Alaska (Figure 14) regions and was included in global measures initially with justification provided previously. Elmendorf is the large facility with in-patient services located in Alaska and was rated the most efficient. Considering the geographic separation from the continental US, 6.13 days average pipeline does not indicate the same level of concern as it might elsewhere in the country.

Table 14. TRBO 11/11-Alaska DEA Efficiency

		Outputs	Inputs							Trial Weighted Factors		
	DMU	Order Lines Output 1	Manpower Input 1	Lead Times Input 2	Include DMU		Focus	DEA Efficiency		Output	Input	Efficiency
1	DMU 1	1661	15	6.01	1	1	DMU 1	FAIRCHILD AFB, 92ND MG/SGSL	1	0.35	0.91	39%
2	DMU 2	19268	68	6.13	1	2	DMU 2	ELMENDORF AFB, 3RD MDSS/SGSL	2	4.11	4.11	100%
3	DMU 3	840	10	9.28	1	3	DMU 3	EIELSON AFB, 354TH MG/SGSL	3	0.18	0.60	30%
Incl Factor:		1	1	1								

Though not candidates for additional delivery sites because of contract terms and currently serviced by the Army through USAMMC as mentioned, the model was ran with EUCOM (Table 15) to keep under management advisement. All of the pipeline times were at least two calendar weeks, Lajes Field nearing a calendar month. Lakenheath, was rated the most efficient with the variables used. As stated earlier, the implications for overseas implications are limited with the information provided.

Table 15. EUCOM DEA Efficiency

		Outputs	Inputs							Trial Weighted Factors		
	DMU	Order Lines Output 1	Manpower Input 1	Lead Times Input 2	Include DMU		Focus	DEA Efficiency		Output	Input	Efficiency
1	DMU 1	50	8	29.17	1	1	DMU 1	LAJES FIELD, 65TH MG/SGSL	1	0.02	0.35	7%
2	DMU 2	5311	58	14.17	1	2	DMU 2	RAF LAKENHEATH, 48TH MDSS/SGSL	2	2.53	2.53	100%
3	DMU 3	907	25	20.43	1	3	DMU 3	SPANGDAHLEM AB, 52ND MDSS/SGS	3	0.43	1.09	40%
4	DMU 4	769	62	21.91	1	4	DMU 4	RAMSTEIN AB, 86TH MG/SGSL	4	0.37	2.70	14%
5	DMU 5	710	47	21.85	1	5	DMU 5	INCIRLIK AB, 39TH MED GROUP/SGSL	5	0.34	2.05	16%
6	DMU 6	1890	24	25.64	1	6	DMU 6	AVIANO AB, 31ST MDSS/SGSL	6	0.90	1.05	86%
Incl Factor:		1	1	1								

Similar to EUCOM, PACAF and PACAF-Hawaii (Table 16) were run for management information only. Additionally, Hickam was included on this model iteration rather that running it separately by itself where it would have no comparison. In the last run of all

the models, Dr. Jensen's DEA model for the first time failed to return an unweighted efficiency score of 100% on any of the DMUs The DEA efficiency ranking Kadena as the "one best" and weighting Hickam and Yokota as 100% as well can be seen in the Focus DMU Efficiency Solutions (Table 17) also available in each model run, none of which were necessary for analysis until this final one.

Table 16. PACAF/PACAF-HAWAII DEA Efficiency

		Order Lines Output 1	Manpower Input 1	Lead Time Input 2	Include DMU		Focus	DEA Efficiency		Trial Weighted Factors Output	Input	Efficiency
1	DMU 1	1584	13	12.53	1	1	DMU 1	HICKAM AFB, 15TH MG/SGSL	1	0.68	0.79	85%
2	DMU 2	3390	69	12.34	1	2	DMU 2	YOKOTA AB, 374TH MG/SGSL	2	1.45	2.86	51%
3	DMU 3	2563	25	13.29	1	3	DMU 3	MISAWA AB, 35TH MG/SGSL	3	1.10	1.26	87%
4	DMU 4	1303	11	13.62	1	4	DMU 4	ANDERSEN AFB, 36TH MG/SGSL	4	0.56	0.75	75%
5	DMU 5	3660	36	15.01	1	5	DMU 5	KADENA AB, 18TH MDSS/SGSL	5	1.56	1.71	92%
6	DMU 6	1056	26	19.5	1	6	DMU 6	KUNSAN AB, 8TH MDSS/SGSL	6	0.45	1.45	31%
7	DMU 7	2852	37	12.11	1	7	DMU 7	OSAN AB, 51ST MG/SGSL	7	1.22	1.67	73%
Incl Factor:		1	1	1								

Table 17. PACAF/PACAF-HAWAII (Focus DEA Efficiency)

	Focus	DEA Efficiency	Focus DMU Efficiency Solutions	1 DMU 1	2 DMU 2	3 DMU 3	4 DMU 4	5 DMU 5	6 DMU 6	7 DMU 7
1	HICKAM AFB, 15TH MG/SGSL	100%	1	1	0.403217	0.841389	0.972165	0.834386	0.333333	0.63261
2	YOKOTA AB, 374TH MG/SGSL	100%	2	0.548024	1	0.807468	0.418763	1	0.231885	0.941316
3	MISAWA AB, 35TH MG/SGSL	97%	3	1	0.52896	0.968109	0.897597	1	0.356414	0.783672
4	ANDERSEN AFB, 36TH MG/SGSL	97%	4	1	0.403217	0.841389	0.972165	0.834386	0.333333	0.63261
5	KADENA AB, 18TH MDSS/SGSL	100%	5	1	0.52896	0.968109	0.897597	1	0.356414	0.783672
6	KUNSAN AB, 8TH MDSS/SGSL	36%	6	1	0.52896	0.968109	0.897597	1	0.356414	0.783672
7	OSAN AB, 51ST MG/SGSL	94%	7	0.548024	1	0.807468	0.418763	1	0.231885	0.941316

Summary

Wherever the rate of output (lines) is less than optimal based on comparison to the "one best," there exists support for potential cost savings. This study explored the

prospective gains aggregate ordering centers might provide through certain economies of scale using pricing options IAW the PV Gen IV task order. Since the AFMS does not break costs out into per line or sales processed, this does not easily translate to conventional costing models. Following the principles of Economic Theory, increasing output at those sites producing at below optimal efficiency levels would decrease average unit costs (Stevenson, 2007). Shifting operations towards those centers with the highest or higher efficiency ratings, as indicated by the DEA model, via implementation of parent-child relationships or virtual hub-and-spoke would consequently result in system-wide cost benefits through greater outputs.

Undeniably many factors impact efficiency and effectiveness, this study focused on manpower and lead time as they relate to output of lines ordered. The supposition regarding these two variables is that the service fee discounts for hub locations would be significant enough to offset the costs associated with additional delivery sites. In conversations with AFMOA, the researcher expected to find less than 50% operating efficiently compared to the "one best" in the system-wide baseline measure and proportionately less when separated by region. Had this been the case, it would have warranted reconfiguration, in those affected areas.

For the exception of one (Keesler), the large MTFs were rated in the highest 20% efficiency, if not the "one best." Furthermore, several smaller sites rated the most efficient, indicating an "all or none" approach to implementation would not be appropriate. Where this was the case, further research into procurement practices, perhaps utilization of resources was indicated.

V. Conclusion and Future Research

Conclusion

Reducing ROF designation by implementing aggregate ordering centers will have the service-wide impact of an overall reduction in service delivery fees per capita. This is based on contract terms delineating a required basic distribution fees associated with the establishment of an ROF regardless of the service level, currently within the range 4.05-4.55% for each of the 11 CONUS regions. The stand-up of virtual hub-and-spoke relationships should not be applied in every region to every ROF but considered as alternative in organizations where productivity measurements suggest resources are not being utilized efficiently and effectively. The intent of the study was not to direct AFMOA of corrective action(s), but rather to provide analysis of past performance in the current supply chain network structure and offer a tool with alternatives for potential in the future.

Benefits of the Study

Though some shift in manpower towards hub locations might be necessary to support implementation, the administrative nature of procurement duties is not such to drive a total revamp of the manpower document. Currently, the enlisted AFSC 4A1 careerfield is 116% manned across the Air Force. For purposes of this study, analysis presumed an authorization equaled a filled position (Table 1). However, this number

should not be misconstrued to equate to Airmen actively engaged on a daily basis in direct support of those tasks that would be affected by the hub-and-spoke.

While there are multiple functions of the Medical Logistics Flight having tangential or less relation(s) to these inventory-related duties, e.g. services contracts or facilities management, implementation could create excess capacity at node locations. Conversely, the hub facilities would likely have a new requirement for manpower in addition to increased costs associated with the greater administrator burden, though not nearly proportionate to the benefit of cost savings. In fact, this restructuring would ultimately “free up” staff members assigned to acquisitions areas at medical logistics accounts, having incredible manpower implications both locally and above.

This manpower consideration is secondary to the potential for cost savings AFMOA is most interested in.

Recommendation

Whether or not the PV intended for sites to be assigned this way or not is unclear. There are no maximum distances or restrictions regarding crossing state lines to prevent the implementation of such a network; the only restriction is that delivery sites are within the same region. As pointed out in model analysis, the regional restriction is actually quite burdensome in some instances, especially where only two or three ROFs share the region, e.g. Langley and Seymour Johnson. Regardless, PV has the flexibility to continue to use DCs of their choice and supported node orders never reach ROF destination, begging the question about such a disparity between under and

over 25 miles radius fees (.23-1.1%). However, an inquiry of this nature would be expressly outside the scope of this study.

Based on the sponsor's request for analysis of the current structure and a tool that would assist with optimization, specifically defining sites that would make "good hub" locations, the recommendations are as follows:

1. Conduct cost analysis for the past twelve months using each of the large facilities in a one-to-one ratio (for the exception of Keesler) with each ROF in the region
2. Check feasibility based on MAJCOM assignment of each hub-and-spoke relation for cost comparison with previous 12-month spend
3. Immediately inquire about Keesler Low Unit of Measure and 52 account break-out costing 4% differential

Mrs. Sykes explained the increased workload due to manual processing should communication not occur between affected ROFs and the regional Contracting Officer to ensure the hub received credit for previous sales once the supported ROF contract became null. She said the system is "set-up" to combine the contracts and all pricing terms however it "loses" all the information from the supported ROF once the site becomes an additional delivery. Therefore, the Contracting Officer must be made aware of monthly totals up to that point to document it accordingly, in order to qualify accurately for annual purchase commitment discounts. As much as possible, the recommendation is that modifications be made during regular contract renewals.

Future Research

The alternative structure will generate increased workload at those aggregate ordering centers, supporting potentially up to 15 sites. Prior to embarking on this endeavor, some research in the area is warranted. With today's sophisticated software systems available across the AFMS, daily inventory duties should not be labor intensive for the clinical staff tasked to carry them out. In fact, beyond custodian training to familiarize with the software system, ideally performance of supply custodian duties requires little to no intervention. If an efficient network were coupled with effective logistics account management, it would have an immeasurable impact on the AFMS with respect to asset flexibility, agility and readiness.

The data collected, compiled and mined for this study far exceeded the time, scope and resources available. Investigation into SLEF option selection using Delphi or other surveying methods might serve to contribute to the work on motivation theory. Along those same lines, ROFs are expected to attempt to source from the PV prior to procuring from other sources. The data collected from the MTFs indicated poor utilization. Without accountability for the MTFs when they fail to source as mandated, little conclusive information can be drawn absent scientific data.

Future Implications

In an effort to optimize the current AFMS supply chain network, this research sought to glean potential benefit from balancing the number of stand-alone ROFs with aggregate ordering centers that could support up to 15 additional node sites at a reduced cost. Before embarking on such a herculean effort as to restructure the organization of

seventy plus organizations, an assessment of the current structure for efficiency and effectiveness was necessary. While looking for an appropriate measurement to assess these productivity calculations, the researcher became familiar with DEA, specifically Dr. Jensen’s model and has since explored its potential for other applications. The robustness of DEA for comparing firms with similar assets responsible for like programs will have invaluable implications across the AFMS.

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Vita

Captain Tereca V. Benton graduated from Bradwell Institute in Hinesville, Georgia in 1994 and went on to earn an Associate's Degree from Middle Georgia College in Cochran, Georgia. This was followed by successful completion of her undergraduate work in Psychology at University of Illinois, Springfield, where she graduated in 1998. She enlisted into the Army that same year and attended Basic Combat Training at Fort Leonardwood, Missouri followed by Advanced Individual Training at Fort Sam Houston, Texas as both a Combat Medic and Mental Health Specialist in 1999. Then Specialist Benton had her son, Jacob in 2000 and was promoted to Sergeant soon after while stationed at Fort Stewart, Georgia. She accepted assignment at Fort Jackson, South Carolina where she served as an instructor/writer for Basic Trainees and finished her time in the US Army serving as the Voice of Victory for nearly two years. After earning a Master of Healthcare Management degree, then Sergeant Benton obtained a direct commission to the US Air Force and was selected for a medical logistics internship that took her to Nellis AFB, NV in 2005. She attended Commissioned Officer Training at Maxwell AFB, AL followed by Health Services Administration school at Sheppard AFB, TX before returning to Nellis to complete her internship. She served as the Medical Logistics Flight Commander at Robins AFB, GA before applying to attend AFIT. After earning her Master of Logistics Management degree, Captain Benton will be assigned to a field team with the Air Force Medical Operations Agency, Medical Logistics Division at Fort Detrick, MD.

Appendix A.

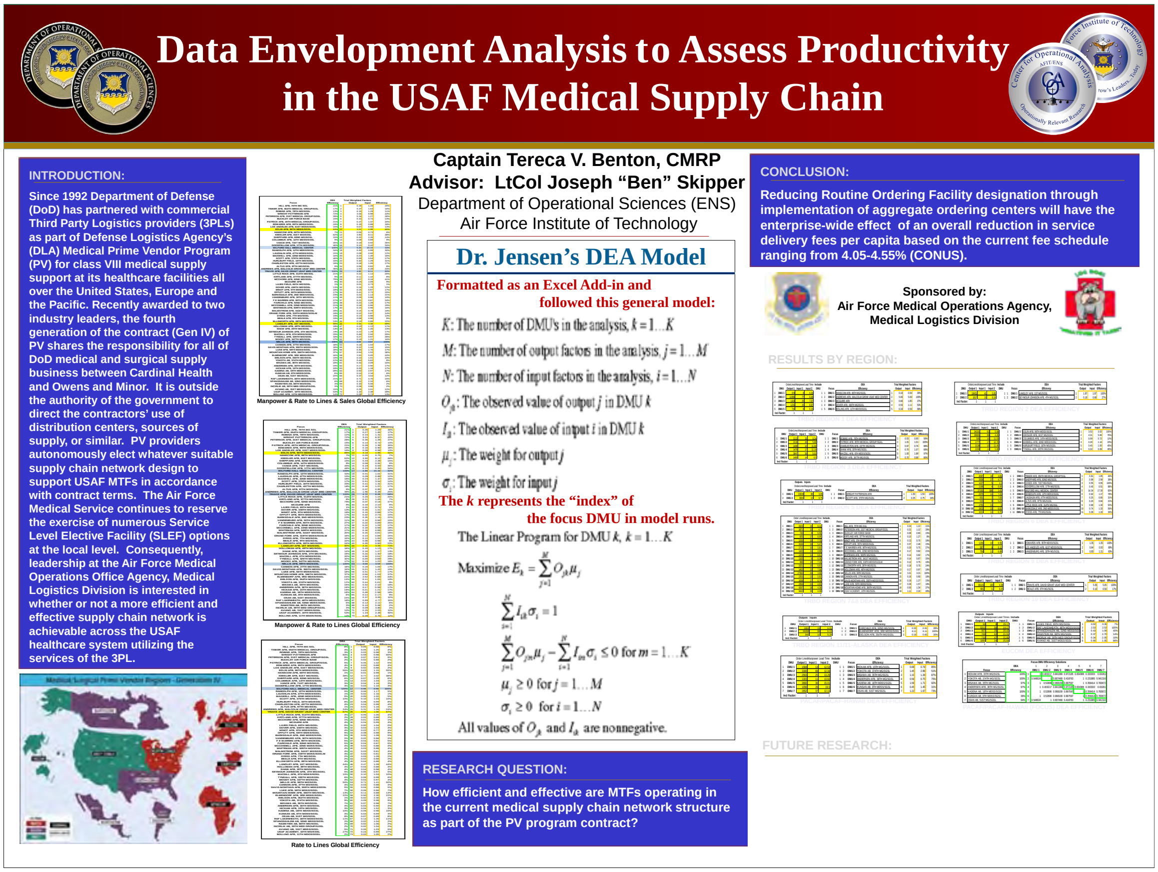
Blue Dart

The current United States Air Force Medical Supply Chain supports healthcare operations based largely on the network configuration of its contracted Third Party Logistics providers. Six years from conception to initial award in 1992, Defense Logistics Agency's triumph with the Medical Prime Vendor contract marked fulfillment of significant and longstanding gaps in cost, quality, and timeliness for all three services. This study seeks further gains, specifically, system-wide efficiency and effectiveness optimality from alternative network reconfiguration.

Utilizing a Data Envelopment Analysis model created by Dr. Paul Jensen, formerly of the University of Texas, each of 73 Air Force Medical Treatment Facilities was assigned a baseline efficiency rating in the current structure. Efficiency was calculated based on the facility's capability to process input(s) to output(s). Effectiveness, operationalized as application of the appropriate strategy "to get the job done," was assessed as a function of lead time using average delivery days. Capacity utilization was also considered. Contract specifications and manpower authorizations for FY 2011 in addition to sales, receipts, order lines, and lead times for the previous two years were inputs and analyzed. Through a combination of contract and user-defined constraints, the model indicated several optimal locations for aggregate ordering centers by region, ultimately suggesting multiple virtual hub-and-spoke networks. Though not the focal point, the manpower and asset implications naturally became of significant consequence when considering the potential for a restructuring of this magnitude.

Appendix B.

Quad Chart



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14. ABSTRACT
Utilizing a DEA model created by Dr. Paul Jensen, of the University of Texas, each of 73 AF MTFs was assigned baseline efficiency rating in the current medical supply chain network structure. Efficiency was calculated based on the facility's capability to process input(s) to output(s). Effectiveness, operationalized as application of the appropriate strategy "to get the job done," was assessed as a function of lead time using average delivery days. Contract specifications and manpower authorizations for FY11 in addition to sales, receipts, order lines, and lead times for the previous two years were inputs and analyzed. Through a combination of contract and user-defined constraints, the model indicated several optimal locations for aggregate ordering centers by region, ultimately suggesting multiple virtual hub-and-spoke networks.

15. SUBJECT TERMS
Data Envelopment Analysis, Aggregate Order Center, Hub-and-Spoke, Virtual Network, Efficiency, Third Party Logistics, Military Prime Vendor, Medical Supply Contract, Linear Program

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